



FRIDAY, DECEMBER 28, 1900.

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Contributions

Classifying Locomotives.

TO THE EDITOR OF THE RAILROAD GAZETTE.

I sympathize thoroughly in "Roadmaster's" opinion of present methods of classifying locomotives, especially upon my own railroad. (See *Railroad Gazette*, Dec. 7, p. 803.) To me it is thoroughly "arbitrary and incomprehensible."

Some twenty years ago I learned only too thoroughly a classification which grew as I grew, so that, arbitrary as it was, I thoroughly comprehended it. A's, B's and C's, obsolete as they are, still vividly recall the old engines. But, alas, one day we outgrew the alphabet and a new classification came in with the new engines. I suppose the new classification is no more arbitrary than the old, but I am too old a dog to learn new tricks unless there is some sort of a key to them. And with me I fancy are many of the general officers, for I notice they are strangely silent when our motive power men prattle in the new Volapuk.

But while I sympathize with "Roadmaster" I can hardly approve his new scheme. It looks pretty in print, but it would be hard to write plainly, and it is entirely beyond the scope of the typewriter. Beside this, it would be well nigh impossible to "talk" unless we could be trained to speak of an English Express engine as a "Little one, big one, little one."

Let me suggest to "Roadmaster" that he amend his scheme by adopting letters instead of numerals, the capitals to denote drivers and the small letters truck-wheels and trails. Thus A as the first letter would mean a single pair of wheels, B two pair, etc., as shown in sketch. Figures could be used for affixes as at present.

This would be easy to write and typewrite, and in talking we are fairly well used to the mention of large and small letters.

It might, however, be found in practice that it would be safe to allude to an "aC" for a Mogul or a "bB" for an "American" without bothering with allusion to the size of the letters.

SUPERINTENDENT.

Load Carried by Norfolk & Western 50-Ton Cars.

American Car & Foundry Company,
Detroit, Dec. 11, 1900.

TO THE EDITOR OF THE RAILROAD GAZETTE.

Referring to the criticism in your issue of Dec. 7 (p. 803) by Mr. W. H. Lewis, as to published data concerning the Norfolk & Western 50-ton hopper cars, in comparison with similar equipment, which appeared in your issue of Oct. 26 last, please note the following facts:

First, the data as originally published was intended to be comparative only, and is so headed in the tables.

Second, This of course presupposes a basis for the comparison, and the selected basis is coal weighing 52 lbs. per

cu. ft. loaded in cars to the top of a 30 deg. heap as a maximum.

Third, This basis was taken because all available information goes to show that for the country as a whole, 52 lbs. per cu. ft. is a fair average for all kinds of coal freight.

Fourth, In the cases of the seventh and eighth items shown in the first table on page 703, your issue Oct. 26, no car numbers are given because the data relating to these items was obtained from information previously published in the *Railroad Gazette*, and was therefore supposed to be authoritative. For all the other items mentioned, the marked light weights were actually noted from the cars themselves. In this connection Mr. Lewis' attention is respectfully invited to page 534, No. 30, Vol. XXXI, *Railroad Gazette* (1899). Under the heading, "New 100,000-lb. Capacity Coal Car of the Norfolk & Western" we find the following: "A sample car of their design has been completed," and "has proved so satisfactory that material has now been ordered for 1,000 of these cars, which will be built at the Roanoke shops. It is expected that their weight will be about 38,000 lbs." etc. Finally, it should be remembered that the sole object in tabulating all this information, has been and is now to shed light on a discussion that has been raging for the past several years, as to the possibility of designing satisfactory structural steel hopper equipment having as favorable a ratio of dead weight to paying freight as any other type. As to where Mr. Lewis stands on this aspect of the proposition, the writer has no doubt whatever.

GEO. I. KING,

Manager Steel Car Department.

The North-West Railway Club—November Meeting.

Following are extracts from the discussions at the November meeting of the North-West Railway Club:

Wear of Locomotive Driving Wheel Tires.

Secretary Poque—While the wheel base has an important bearing, the design of the truck hangers has, I believe, even a greater influence, and it is in regard to some changes in the hangers that I will speak. Our consolidation engines, Class M, have a rigid wheel base of 14 ft. and a total wheel base of 21 ft. 4½ in. The front and back tires are flanged. The truck hangers are 8 in. long, spaced 25 in. apart at the top and 23¼ in. apart at the bottom, giving an outside angle of about 6¼ deg. from the vertical. These engines have been notoriously bad about cutting their flanges.

Consolidation engines, Class P, with a rigid wheel base of 15 ft. and a total wheel base of 22 ft. 5½ in., have truck hangers 8½ in. long, spaced 24 in. apart at the top and 27 in. apart at the bottom, giving an inside angle of about 10 deg. from the vertical. The flange wear on these engines is much less pronounced, and that it should be so is borne out by the report of the Master Mechanics' Committee, on page 123 of the *Proceedings* for 1897. The results obtained by this committee would indicate that the hangers on these engines should be farther apart at the bottom. This might reduce the flange wear to a minimum, but the principle of the inclined hangers seems wrong. In certain positions of the hangers the forces resulting from the weight of the engine truck are in direct opposition to each other. Furthermore, any movement of the hangers tilts the center casting. Hangers that are vertical in their normal position do not have this objection, but they cause a greater stress on the engine truck wheel flange and allow a greater swing to the boiler. We have lately adopted the heart-shaped or three-point hangers, which have the advantage of being always parallel and still have a much greater tendency to assume their normal position. On three of our Class M engines this type of hanger has practically eliminated flange wear up to the present time, and I see no reason why it should not continue to do so.

We have also tried flanged tires on all the driving wheels of a consolidation engine, with very good results, but I think that the better solution lies in the design of the truck hangers.

Mr. Howard Curry (Northern Pacific)—There is quite a difference in the wear of a tire on different divisions of our line, and I am inclined to attribute it to the soil. On our eastern division here, particularly out of St. Paul, the soil is very sandy and it is a sharp sand. It is very noticeable on the district out of St. Paul here that the tires wear flat much more rapidly than they do on some of the divisions west of here. At one time I had charge of engines that came from two different shops on our line, and had about made up my mind that a little difference in the manner in which the engines' valves were set had something to do with it; but later on changes were made in the distribution of power and the engines that came out of the same shop were assigned to the territory that the engines that I had supposed had their valves set differently were running on. The same condition exists with the engines coming from the same shop, which was conclusive proof to me that the matter that I just mentioned had a great deal to do with the flattening of the tire. There is no question but what an engine running on a level division will flatten a tire quicker than one running on a division that is more rolling. The heavy trains hauled, and the disposition that is shown by men at times to hurry the engines in starting heavy trains, has a tendency to bring about the imperceptible slip, and very many times, very perceptible in starting heavy trains, which is much longer continued on a level division than it is where the country is more rolling.

Mr. F. B. Farmer (Westinghouse Air-Brake Co.)—I

wanted to mention an innovation in the design of the brakehead, the object being to get more uniform wear of the tires, considering the cross-section. This would have to do with the wear of tires and with the condition of them. About a year ago, when some brakes were being built for the Great Western, Mr. Van Alstine suggested the desirability of making a change in the line of applying the brake shoe pressure to the wheel, that is, the vertical line. It appears that in the original driver brake a plain shoe was used and the hanger was located centrally on the brake head. Then, with the change that came about through recessing the shoe and applying the flanged portion, the hanger was not altered, with the result that at present the preponderance of pressure comes on the outside portion of the shoe and necessarily on the tread. The matter was brought to Mr. Van Alstine's attention through the use of the cast steel shoe, which he found very satisfactory as a tire dresser, but which scored the outside portion of the tread in some instances, and his idea was to transfer some of this pressure over to the flange and dress it a little more rapidly and the outside less so. The results so far have been apparently quite satisfactory. I know of two roads that have had occasion to use a flange moistening appliance, the Duluth, Missabe & Northern, on their new engines, and the Lake Superior & Ishpeming. The last mentioned road had trouble with flange wear, having a very sandy district. The track was put up according to improved methods, but is very crooked, and they could get no relief. They tried putting on all flanged tires until they applied this sprinkler, and since then their tire wear has been reduced to what they consider a satisfactory amount, considering the service, and the sprinkler not only has the effect of lessening the tire wear on the locomotive, but on the cars as well. Except in hot weather you can notice the dampness on the rail after thirty cars have passed over. On the hill engines of the Duluth, Missabe & Northern they have applied it both forward and back, as they are not turned, and seldom have any difficulty with the engine slipping on account of its use; in fact, if the jet is projected slightly against the rail it serves even to improve the condition of the rail by washing it off. The engines are consolidation, heavy, with a pretty long rigid wheel base.

The Utilization of Air Pump Exhaust for Heating Feed-Water on Locomotives.

The Secretary read the following notes by Mr. David Van Alstine (C. G. W.): "In suggesting this topic for discussion I wished to ascertain from the members of the club whether or not they have found it practicable to exhaust air pumps directly into the tank water, instead of passing it through radiating pipes, without having any injurious effect on the boiler from the collection of valve oil."

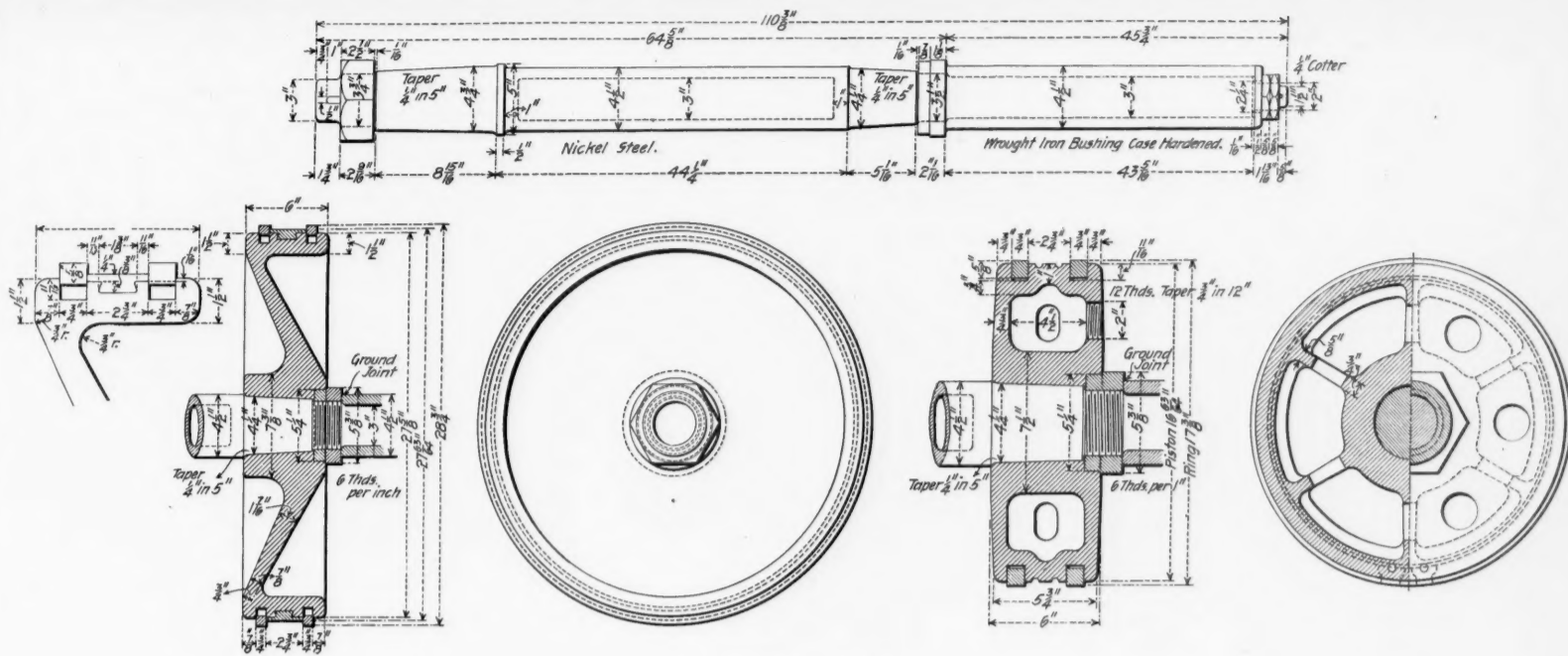
"Tests recently made on the Great Western showed that with a 9½-in. pump exhausting directly into the water in a 6,000-gal. tank, the rise in temperature per hour was practically uniform, with a uniform decrease in the amount of water in the tank."

"The limiting temperature at which injectors in ordinary service will safely handle water is about 90 deg. to 100 deg. With initial feed-water temperature of 50 deg. and final temperature of 90 deg. the mean is 70 deg., or 20 deg. average increase in feed-water temperature due to heater. This is equivalent to less than 2 per cent. saving in coal. This, with a freight engine making ordinary mileage, and coal at \$2 per ton, will amount to net saving of \$6 or \$7 a month, after allowing for cost of maintenance of the feed-water heating apparatus. Hotter water can be handled with a pump, but there appears to be no advantage in the pump, either theoretically or practically, over the injector, except, perhaps, as an auxiliary in case water becomes too hot for the injector."

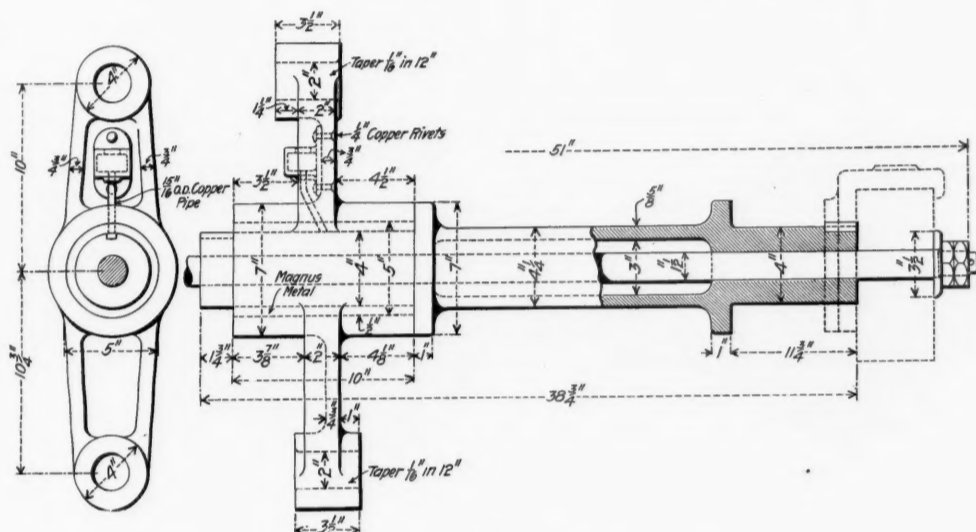
Mr. Van Alstine sent two charts, showing the temperature of the water and the gallons of water in the tank during several tests. In the first case, they started out with 5,868 gals. of water in the tank at a temperature of 85 deg., and had 4,101 gals. left at a temperature of 96 deg., showing a rise of 11 deg. in about an hour's time. In another case, 1,093 gals. of water were used in one hour and twelve minutes, the initial temperature being 50 deg. and the final temperature 60 deg. The amount of water in the tank at the beginning of this test was 5,691 gals. and at the end of test 4,598 gals. In a third case, starting with 5,780 gals. at a temperature of 56 deg., the test was continued for four hours and 22 minutes, at the end of which time there were 3,058 gals. of water in the tank at a temperature of 102 deg. Two hours and twenty-eight minutes of this time was spent in switching.

Mr. Kellogg (C., St. P., M. & O.)—We exhaust directly into the tank. We have a pipe extending from the tank valve to the rear end of the tank. When we first put them on we used coils. We found that was not necessary, and afterwards tried exhausting directly into the tank without using any pipe. We found that this heated the water so hot around the goose-neck that if you used the right hand injector you would have some difficulty in working it, that is, it would heat the water right around the goose-neck. We extended the pipe to the rear end of the tender and experience no trouble.

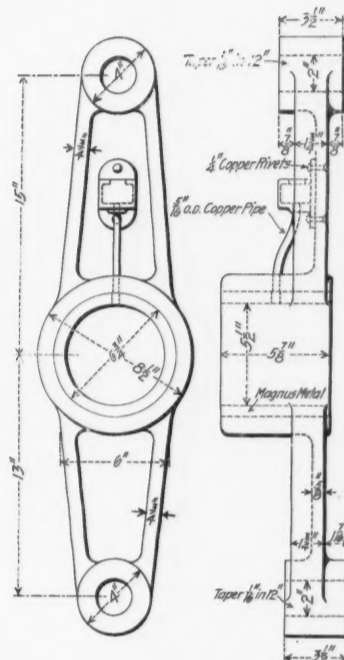
Mr. Lovell—On the Northern Pacific when we began equipping engines in this way, three years ago, engineers were skeptical in regard to their ability to use the hot water with the injector. When they got the water above 70 deg. they would begin to be afraid of it. But, after educating them, as Mr. Kellogg said, to the fact that they could use water up to 100 deg., we have very little trouble. We have over 100 engines equipped with hot water apparatus in the tank, and I think it is pretty generally used. I think as a general rule the engineers use the



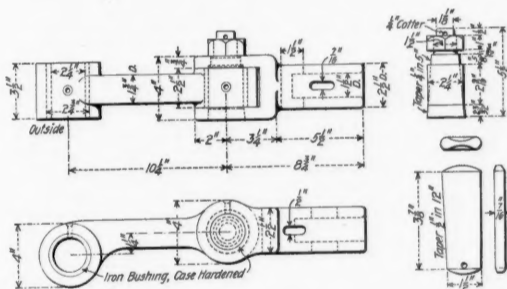
Pistons and Piston Rod.



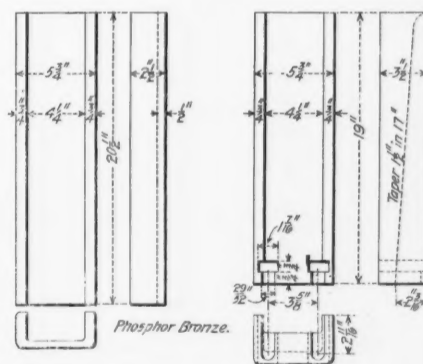
Front Rocker Arm and Shaft.



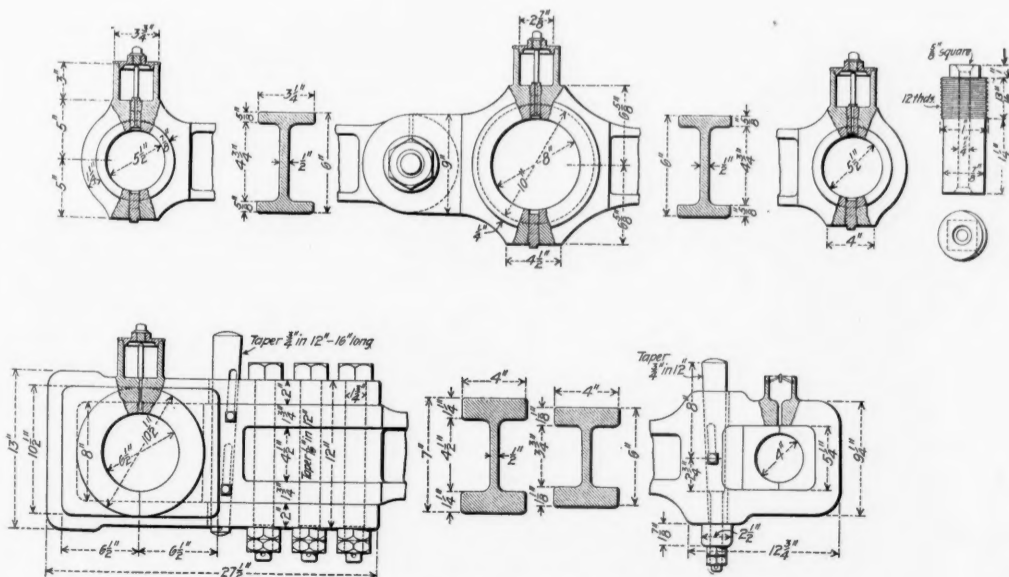
Back Rocker Arm.



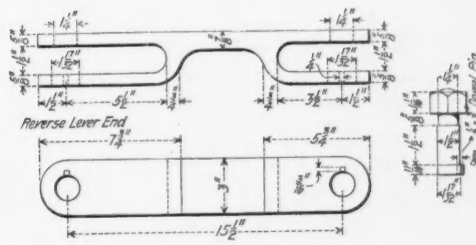
Valve Rod.



Shoe and Wedge.



Main and Connecting Rods.



Reach Rod.

American Practice in Block Signaling.*

By B. B. ADAMS.
XIII.

We have now examined the two methods of block signaling by the aid of electricity, and their principal sub-divisions, viz., (1) manual, (a) simple, and (b) controlled by electro-mechanical means; (2) automatic by (a) disks, (b) enclosed disks, (c) semaphores worked by mechanical power, and (d) semaphores worked by electric batteries. Seeing these different kinds, all of them, except one, still in favor in one place or another, the reader may, not unnaturally, desire to make a comparison of their relative merits; or at least to inquire why such a variety is necessary or desirable. Only a qualified answer can be given to this question, for the art of signaling is yet comparatively young and some ideals, which are by no means impossible, are still unattained. Some of the devices in use, though efficient, are still undergoing improvement. At first but few railroads introduced block signals until they were practically compelled to do so, by pressure of increased business or by difficulties in disciplining trainmen to observe the necessary safeguards in running trains without block signals. They therefore felt it necessary to take the best apparatus or method available at the time, without making exhaustive comparative tests. Progress has, therefore, been rather intermittent and unsteady, and the state of the art can hardly be called well settled.

The original method of spacing trains—by maintaining an interval of time, of from 5 to 15 minutes, at every station, between each two trains running in the same direction—may become unsatisfactory for either or both of two reasons: (1) too many trains, so that the shortest practicable time interval is too long and causes delays to the trains; or (2) difficulty in warning the following train when the leading train is delayed between stations and uses up the time interval.

Under the first head the question is, How short a time is sufficient to warn a second train in case the first is unexpectedly stopped? In clear weather, in daylight, on a level prairie, probably three minutes would be deemed long enough. But every railroad is subject to foggy weather, and those in cold climates have to contend with snow, so that in making general rules it is necessary to prescribe an interval long enough to insure safety under these adverse conditions; and five minutes is the shortest time interval in common use. Trains running at the rate of a mile a minute must therefore keep five miles apart. Block signals, fixed so as to permit trains to run only one mile apart will therefore increase the capacity of a railroad under these conditions five-fold. Where curves or tunnels are numerous a longer time interval is desirable, and 7 minutes or 10 minutes is the rule on many roads. With this the need of the block system is, of course, felt sooner than with a short interval. Where the distances between stations are more than, say, five miles, the time interval system becomes unsatisfactory by reason of the varying speed of trains. A light train leaving a station at 8:05 may in a few miles overtake a heavier train which left at 8:00. An essential element in the safe operation of the time interval system is the maintenance of a uniform rate of speed with all trains of the same class, and this is often difficult.

The second point is the difficulty in warning following trains. Fogs and snows, already mentioned, obscure the engineer's view and therefore make it necessary for a man to go back with a flag or lantern a half mile or more. On a crooked road in a hilly country this is the minimum distance at all times, whatever the weather. The faster the trains run, the longer must be the time interval, to permit the flagman to go back farther. The irksome nature of the work tempts flagmen to neglect their duty; delays due to waiting for a flagman to return to his train tempt conductors to shirk sending out a flag; leaving a flag displayed after its train has resumed its journey, deceives the following engineer; and leaving a separate flagman behind on the occasion of each detention deprives the train of brakemen and delays the following train to pick up the flagman. All these circumstances combine to make the time interval unsatisfactory, and failure to carry out the regulations causes a collision every now and then, entailing loss of life and property.

But unsatisfactory as is the time interval and flagging system, the block system is a costly substitute for it. A road running only one train a day, or keeping only one engine under steam, obviously needs no block system. A number of trains may be run while yet the expense of keeping an attendant on duty at every station, day and night, or even continuously during the day, may be deemed unwarranted. But as soon as a road has enough business to warrant the employment of regular station agents on duty all the time, it should have the block system. The managers of thousands of miles of railroad, by their action, if not by their words, deny this; but on the other hand some of the wisest and most experienced managers agree with this view. Imagine a road with stations 15 miles apart and trains running over the line once in two hours (average interval). The block system is not used on many such lines; and yet the enforcement of a time interval of 20 to 30 minutes between passenger trains and of 30 to 60 minutes between freight trains would make it possible to use the space interval, with its greater safety and more satisfactory conditions. Those superintendents who have adopted the block system with long block sections testify that the enforcement of the long time intervals necessary to do this (long as compared with

former practice) is not nearly so difficult as had been feared. In fact, it is not difficult at all.

With a moderate number of trains the manual is the only block system that can be used, because the cost of the apparatus for the automatic system would be prohibitive; whereas, the attendance necessary with the manual system can be devolved upon station agents, whose other duties are light, and whose attendance at their offices will cost nearly or quite as much if they do not do signaling as if they do. Only one railroad has made extensive use of automatic signals on a single-track line.

The introduction of electrical apparatus, like Coleman's, in connection with manual block signals makes a considerable addition to the expense. Such apparatus, to be of value, must have every possible safeguard, and must be supervised with intelligence and care to make sure that the safeguards provided are regularly used. It has been but little used except on important lines; and if we may judge by the action of the large number of railroad companies which have considered it but have not adopted it, its value is a point on which there is as yet no satisfactory agreement.

Coming now to automatic block signals, the principal question is not whether or not to use the space interval, but what kind of apparatus to use. As already intimated, a road cannot afford the outlay necessary to put in automatic signals unless it has a considerable traffic, and these signals were first put in chiefly by roads with ample capital. In the early years of automatic block signaling the question of the reliability of the apparatus was a chief element in deciding whether or not to use a given design, and there was much discussion whether or not a machine could perform signaling functions with the uniform safety which is secured by employing a man at each signal station. Those who believed that the machine was not to be trusted and who yet felt that the liability of men to forget was a weakness of the manual system, were inclined to adopt the electric locking apparatus, of which the Coleman machine is an example. Perhaps the most instructive example in America is that of the Pennsylvania Railroad. This company introduced manual blocking extensively on its main line more than 20 years ago, and to some extent more than 30 years ago. Cabins were built, separate from stations, and very little of the signal work was done by men having other duties, so that the cost of the system was heavy. But the traffic was also heavy and the expense was deemed fully justifiable. After using the automatic signals in a limited way for a few years, however, the company began to extend them quite fast, and now has protected by them about 500 miles of track on lines which formerly were signaled by men; so that there can be no question that as far as safety goes automatic signals are deemed fully as satisfactory as the manual system. And the abandonment of scores of cabins, with their night and day attendants, has, of course, made a large reduction in the monthly expense account.

The relative desirability of the different kinds of automatic signals is a question that cannot be entered into here, for to do so with any thoroughness would take the discussion beyond the bounds of this series of articles. Moreover, the element of cost has been an important factor with railroad officers in deciding what to use. But a few obvious comparisons, already touched upon, may, for convenience, be restated here. The disk, unprotected from the weather, is still in use and is so satisfactory that one road which took some of this kind out, to introduce a later design, on an important line, re-erected the disk signals (clock-work) on a line which was less important but still not an unimportant one; but no new outdoor disk signals are being put up, because, first, the enclosed disk has become better known, and, second, the automatic semaphore has been cheapened and improved. The expiration of patents on some devices has led to improvements. The enclosed disk is superior to the outdoor, because it can be worked with much less power. The semaphore, in turn, is superior to the enclosed disk because it cannot be obscured by snow or reflected light on the glass, though it requires more power. The development of the electric motor and the improvement of frost-proof batteries has made the electric semaphore possible. Motors and economical batteries were unknown when the clockwork signal was invented. Automatic electric semaphores protecting 35 miles of four-track railroad are now worked by a dynamo at a central station, feed wires being strung along the line of road and storage batteries being introduced at each signal, or where necessary.

The electro-pneumatic signal has been developed somewhat independently of other kinds. The cost of a power station for compressing air is a large item of expense, and except on the Pennsylvania Railroad no block signals of this kind have been put up unless a compressor was installed for a large yard. Perhaps the Pennsylvania is not an exception, as there are numerous yards on those of its lines which have electro-pneumatic block signals; but evidently the company believes this type of signal the best for all double-track lines on which the traffic is heavy.

As before stated, the Pennsylvania Railroad has shown by its action that automatic are deemed as safe as man-operated signals. A precise comparison of the relative safety of the two systems cannot be made for the reason that the number of lives saved by the use of the one system as compared with the other, or by either, compared with no block signals at all, cannot be fairly computed except by considering a long series of years. The amount of money saved by the prevention of collisions is also hard to compare, as between the two systems, for the same reason; though as between a block system and no block system, some roads have found a decided saving

immediately on the introduction of the space-interval, the number of minor freight-train collisions being at once reduced.

With man-operated signals no record is available of the number of errors made in a thousand or a million train movements, although errors have been made, resulting in collisions, not only with the simple manual system but also with the "controlled manual." For automatic signals a few records have been published. These give failures under two heads, (1) failures which cause delay only, (2) failures which may cause a collision by showing a signal "all-clear" when it should show "stop." From the standpoint of safety we consider only the latter class. In the operation of automatic signals on the Chicago & Northwestern Railway for seven years, with over three million signal movements yearly, the proportion of false clear indications has been about one to one million. A similar ratio was given in a statement published by the Philadelphia & Reading. The latest record from the Pennsylvania road is one of somewhat earlier date and shows 1 to 635,151.

The cost of installing and maintaining automatic signals is a question which, like that of deciding when and to what extent the block system shall be introduced, must be decided largely by each company for itself, local circumstances varying widely. A few general statements will serve as landmarks.

The Philadelphia & Reading has spent for enclosed disk signals from \$1,500 to \$4,000 per mile of road. The cost per mile varies according to the length of the block sections and the frequency of the switches. The larger sum refers to lines with more than two tracks with a distant signal for each home signal, the distant being on the same post with the home signal of the next block section in the rear. The cost of disk signals has been reported in various cases as about \$400 per signal. The cost of maintenance of disk signals has been reported at from \$67 to \$100 per signal per year. For semaphores worked by electric motors, actuated by batteries, a complete equipment for a double-track line, with distant signals, costs from \$1,200 to \$1,800 per mile.

The cost of electro-pneumatic signals on a four-track railroad, with block sections averaging three-fourths of a mile long, was, in a certain case, \$5,000 a mile, which, of course, included distant signals. The cost of maintenance of signals of this kind for one year, including oil and attendants for the lamps, material and attendants for the batteries, air compressing and repairs to the compressing plant, is given for one four-track railroad as \$33.93 per signal arm. The cost per mile of road, with blocks of the length just mentioned would, therefore, be \$362 a year.

To state where and to what extent each of the different methods and appliances for signaling are used would take us beyond the scope of the present series of articles; but as an interesting statement with which to close the series and to give the reader some adequate notion of the importance of the subject, I may give the total length of railroad in the United States on which block signals are used. From data just gathered from 56 of the principal railroad companies this total is shown to be approximately 26,102 miles. This includes lines of the Cleveland, Cincinnati, Chicago & St. Louis (1,286 miles), the Michigan Central (355), and the Southern Railway (5,935), where the block signals are used only to protect passenger trains; also 847 miles of the Chicago & Alton, where the block system is enforced only during fogs; but these lines are essentially block signaled lines, for the vital feature is the presence of the facilities and of the men trained to use them. Even the British Government, with its strict standards, has to leave the railroads free to use the permissive block system with freight trains whenever the absolute rule would cause delay. If we deduct the 8,423 miles of these four roads we have in the United States 17,480 miles of line; 15,161 miles worked by manual signals and 2,319 miles worked by automatic signals. With the 8,423 miles included, we have just about ten times as much manual as automatic. On the basis of miles of track, however, the proportion would be different, as of the automatic mileage five-sixths is double track or four track, while of the manual three-fourths is single track. Of the road worked by manual signals about 1,000 miles has the "controlled manual," more than a third of this being four-track line. Within a week or two the figures for each road will be published.

It is the intention of the *Railroad Gazette* to publish these articles in book form early in 1901. In addition to the diagrams which have been given, the book will be illustrated with numerous engravings, from photographs or from makers' drawings, showing some of the apparatus more in detail and on a larger scale; and outdoor views of the various kinds of signals.

The electric staff of Webb & Thompson, as modified in this country, will also be described. This is an efficient block signal device, coming under the head of "controlled manual." Grafton's three-position block signal, used on the Pittsburgh, Fort Wayne & Chicago, only lately put in service, will be described. This signal is used in an important installation, covering about 120 miles of track.

There will also be added illustrated descriptions of the principal types of interlocking machines for working switches and signals.

The management of the Russian State Railroads announces that an order has been given on the building of 1,000 fourth-class passenger cars. These cars are to be used for workmen.

*Previous articles in this series may be found on pages 4, 34, 83, 121, 166, 222, 265, 734, 753, 777, 808 and 838.

Railroad Employees' Relief.

BY J. A. ANDERSON.
(Concluded from page 842.)

In the formation of the Relief Fund, the aim was to provide rates of contribution and benefits that would as nearly as possible balance each other so as to produce neither deficiency nor surplus. Exactness in this respect was manifestly impossible and existing statistics gave but little light to guide in this direction. Therefore, while making the best practicable estimates, which have proved to be pretty near to the actual results, provision had to be made for the contingency of either deficiency or surplus. As already stated, the company assumed the guarantee against deficiency, and further agreed to a provision that any surplus arising during any of the consecutive periods of three years should be set aside as a foundation for a Superannuation Fund, or for other use for the sole benefit of contributing members.

As the accounts of the several corporations in the system are kept distinct, as stated, each having its separate Relief Fund, although all under one management, it may happen that in a given triennial period one may show a deficiency and another a surplus. This has in fact occurred, which explains why there have been large payments for deficiencies, while in the Fund as a whole a considerable surplus has gradually accumulated.

Some irregularities in the financial results have arisen from the occurrence of epidemics. This has not been at all marked from those local in character, but twice the cost to the Fund in benefits paid on account of the prevalence of grippe, has within a few months reached upwards of \$50,000. The provision before stated that during the first six months age and physical condition should not be a bar to membership introduced an element of great uncertainty in the question of probable cost. The evident advantage of the measure to the employees was so great that the company was willing to cover by its guarantee this unknown quantity, which has proved to be very great; but in the nature of things it grows less as the years go by.

It has been urged that upon a member leaving the service there should be returned to him at least a part of his contributions. It is easily seen that this idea is based on a false view of the nature of the arrangement, which is not intended to create a reserve to cover future risks, from which such payments could be properly made, the design being simply that each month shall take care of itself with only enough over to pay for liabilities already incurred in deaths that have taken place, and in existing cases of disablement. Although there is on the Eastern system some surplus, a share of which a retiring member might claim because of having contributed to it, the amount per member is insignificant and the terms of membership provide for its use. As this surplus gradually grew in amount, attention was directed to the proper mode of using it. It seemed best that the original idea of a Superannuation Fund should be carried out. The amount, although large, was not such as to yield in interest sufficient to admit of more than very small superannuation allowances, and it was not until a plan was adopted by the company to honorably retire old and deserving employees of the Eastern system that this question reached a solution. It was then arranged for the Eastern System that from Jan. 1, 1900, members retired from active duty under the regulations then put in operation by the company, should be entitled to stated allowances from a Superannuation Fund derived from interest on the surplus. These amounts are small but afford some help.

The results of operation are shown in the following summaries. The financial year of the Western System, begins with July 1, so that in combining the membership of the two the total is not strictly correct for calendar years. Both, however, are brought up to Dec. 31, 1899. At that date the membership in the Eastern System was 63 per cent. of the employees and in the Western 62 per cent.

Members.

	Eastern.	Western.	Total.
1886	19,952	19,952
1887	18,744	18,744
1888	19,332	19,332
1889	21,457	12,168	33,625
1890	24,984	11,166	36,150
1891	27,200	11,391	38,591
1892	31,640	12,462	44,102
1893	32,327	14,462	46,789
1894	33,405	13,619	47,024
1895	36,432	15,884	52,316
1896	40,853	15,736	56,589
1897	43,675	16,455	60,130
1898	45,141	16,801	61,942
1899	48,529	17,749	66,278

Receipts.

	East. System.	West. System.	Total.
Contrib't'ns by members	\$7,596,398.62	\$2,723,284.62	\$10,319,683.24
Contrib. by Co.—			
Operating expen..	1,172,268.17	490,828.90	
Deficiencies	136,272.37	21,479.36	
Supplemen. Co. relief	363,914.65	56,282.30	
	\$1,672,455.19	\$568,590.56	\$2,241,045.75
Interest on current balances paid by company	240,849.23	43,455.52	284,304.75
Death benefit of the late Pres. Frank Thomson, given by his beneficiaries...	2,500.00		2,500.00
	\$9,512,203.04	\$3,335,330.70	\$12,847,533.74

Payments and Balances.

	East. System.	West. System.	Total.
Benefits—Death—			
Accid't in service	\$770,822.23	\$256,780.52	
Natural cause...	2,373,266.55	742,174.45	
Benefits—Disablement—			
Accid'ts in serv.	\$1,387,384.31	\$717,720.90	
Sickness	2,413,698.34	895,002.67	
Total benefits	\$6,945,171.43	\$2,611,678.54	\$9,556,849.97
Operating expenses.	1,172,268.17	490,828.90	1,663,097.07
Supplemen. comp'y relief	359,008.61	56,098.40	415,107.01
Surplus set aside...	664,481.90		664,481.90
Cash to meet liabilities incurred or to go to surplus...	371,272.93	176,724.86	547,997.79
	\$9,512,203.04	\$3,335,330.70	\$12,847,533.74

The disbursement in benefits of the large sum of nearly ten millions of dollars has been productive of immense good to the recipients. It has been the means of removing some early opposition arising apparently from misrepresentation or misunderstanding, and of greatly strengthening the interest of the employees in the institution as well as in the business of the company through whose beneficent action its existence has been made possible.

A fitting crown to the company's action in the matter of the Relief plan has been the recent inauguration of a Pension System, a subject which the management has long had in contemplation. The way did not seem clear for this at the time the Relief Department was established, but much thought has since been given to its preparation. It could not be accomplished through the surplus of the Relief Fund, as this was not by any means sufficient, nor was it in the power of the company to make this use of it, it being the property of the contributing employees and devoted to their use. The plan in view, moreover, for pension allowances, was designed to apply to the whole service irrespective of membership in the Relief Fund and to be entirely distinct. Such a plan having been fully perfected, the President of the company, on Dec. 18, 1899, announced that a plan of pension allowances for the Eastern System had been adopted to take effect Jan. 1, 1900, to be administered by a "Pension Department."

The arrangement provides that officers and employees of the company who shall have attained the age of 70 years, or who, being between the ages of 65 and 69 years inclusive, shall have been 30 years or more in the service and shall then be physically disqualified, shall be relieved of duty and placed on a pension roll.

Pension allowances not exceeding at any time the aggregate sum of \$300,000 per annum and subject to ratable reduction to keep within this limit, are to be allowed on the basis, for each year of service, of 1 per centum of the average pay for the last ten years preceding retirement. If an employee has been in the service of the company for 40 years and has received an average for the last ten years of \$40 per month in regular wages, his pension allowance is 40 per cent of \$40, or \$16 a month. The pensions are paid monthly and terminate at death. Those receiving them are at liberty to engage in other business but cannot return to the service of the Company.

The Pension Department, under the supervision of the President, is in charge of a Board of Officers, consisting at present of the Vice-Presidents, the General Manager, and the Assistant Comptroller.

In connection with the establishment of the Pension Department, a rule was adopted that no person should be taken into the service of the company who is over 35 years of age; except that, with the approval of the Board of Directors, former employees may be re-employed within a period of three years from the time of leaving the service and persons may be employed, irrespective of age limit, for positions requiring professional or other special qualifications, or for temporary service not exceeding six months, with authorized renewal. The time of service upon which the pension allowances are estimated includes the whole period of continuous employment on any of the railroads or works belonging to the Pennsylvania Railroad System east of Pittsburgh and Erie, whether prior or subsequent to their control or acquisition by that system. A similar pension plan for the Western System has been adopted to go into effect Jan. 1, 1901. It is too early as yet, in the operation of the pension plan, to state results. Through many years the company's officers have given much careful thought and attention to both the institutions described and have shown the deepest interest in their establishment and success. It would be difficult to mention all in the management who have manifested this interest, but it is not out of place to state that what has been said is specially true of the Presidents of the company who have had these matters in charge or under consideration. Mr. George B. Roberts, under whose administration the Relief Department was organized, devoted much attention to its formation and development. He was also greatly interested in the preparation of a plan for pensions for the employees. This was also true of his immediate successor, Mr. Frank Thomson; and in commemoration of his special interest in the Relief Fund, his family returned to it the sum of \$2,500, which, by reason of his membership, was paid to them upon his death. During Mr. Thomson's administration, the pension plan, which had long been in preparation, had progressed almost to a satisfactory conclusion, which was reached soon after the accession of Mr. A. J. Cassatt, who, during his long connection with the management as officer and Director and now as President has manifested the most active interest in these projects.

Their complete and successful establishment must confirm the ties existing between the company and its em-

ployees, so essential to success in conducting its large business; and the value of the company's action in the matter cannot fail of appreciation by the public whose interests are so dependent on the degree of success in railway operation.

Viewed from a strictly business standpoint, the large expenditures by the company in these enterprises have been fully justified by the result. Those most concerned have fully approved the action as most wise in promoting the best interests of the company, and its people and the advanced philanthropic spirit of the age finds it in conformity with that benevolence which Christian people recognize as but justly due from those holding the responsible position of employer to the persons engaged in their service.

The Steam Turbine.*

Steam turbines may be divided into three classes: Impact, as in Bianca's; reaction, as in Hero's; and a combination of these, of which Parsons' is an example. This paper deals only with the two forms which have attained some degree of commercial success, namely, the Parsons' and the De Laval, particularly the former.

The laws governing the best velocity of buckets are the same as for water wheels. In the impact turbine the ideal condition is when the peripheral velocity of the buckets is one-half that of the fluid comprising the jet. In the reaction turbine this velocity must be equal to that of the jet in order to give the ideal condition. With high-pressure steam discharging into a vacuum the velocities obtained are from 3,000 to 5,000 ft. per second, as calculated by Zeuner's formula. A turbine, therefore, built on the lines just enumerated would have peripheral velocities far beyond the limits of strength of material. As an example, a 10-in. Hero's engine would revolve at 75,000 r. p. m.

The De Laval turbine, shown in Fig. 1, consists of a divergent nozzle which directs the jet of steam upon suitably formed buckets. A, which are attached to the periphery of a revolving wheel. The outer edge of the buckets is shrouded by a steel ring, B, which prevents the centrifugal escape of the steam. The distinctive features of this turbine are the nozzle and the means by which the wheel is enabled to revolve upon its axis of gravity. Difficulty always arises in attempting to revolve a body at a high rotative speed. It is essential in the first place that the body be accurately balanced, but in spite of all care this cannot be attained with absolute accuracy. The result is that with ordinary shaft and bearings, tremendous vibrations would be set up that would probably result in eventual rupture of the shaft. De Laval overcomes this difficulty, however, by mounting his wheel near the center of a long light shaft C capable of being considerably bent and returning to its original form. The shaft is mounted upon bearings of ordinary construction. This flexibility enables the forces set up by the revolving wheel to deflect the shaft and enables the former to revolve about its axis of gravity.

The nozzle is divergent. In it the whole expansion of the steam is carried out. The steam at the mouth of the nozzle has the same pressure as the exhaust. In other words the steam has its energy completely transformed into mass and velocity by the time it comes in contact with the buckets. With the exception of the nozzles, and the throats of the nozzles, no parts are subjected to steam pressure. It is well known that the velocity of steam flowing through an orifice, from a greater to a lesser pressure, increases as the difference of the pressure increases, only up to a certain limit. This limit is reached when the lower pressure becomes less than .56 of the higher. Beyond this, however much the steam pressure is increased, the velocity of steam remains practically the same—about 1,476 ft. a second. This limit of velocity seems never to have been satisfactorily explained. It is probably due to the fact that the pressure in the center of the throat is not the same as in the surrounding medium. The jet, after passing the throat, suddenly expands and the change of direction of the fluid particles gives rise to centrifugal forces.

The best length of nozzle is hard to determine. The best shape of the divergency has been the subject of investigation by various experimenters, in order to give the best expansion curve, regarded as a single particle. The writer's opinion is that the best results in this respect are obtained by a nozzle whose section is very near an ellipse.

The investigation of the performance of steam nozzles is particularly interesting. The apparatus usually employed is shown in Fig. 2. The nozzle is at A. The steam entering at B discharges through the nozzle directly into the exhaust pipe. At C is provided a small searching tube, sealed at one end and with a minute hole D some distance from this end. At the other end is provided a suitable pressure gage or mercury column. Means are provided for sliding the searching tube, with its pressure gage back and forth, when pressures may be read in different positions throughout the length of the nozzle. From these figures a curve of pressures may be developed and from this, together with knowledge of the weight of the steam passing the nozzle per unit of time, and the exact form of the nozzle, a second curve may be developed which will give some idea of the velocities of the fluid.

*Extracts from a paper by Mr. Francis Hodgkinson; meeting of the Engineers' Society of Western Pennsylvania, Nov. 20, 1900. For a description of the Parsons turbines used at Wilmerding and an account of tests, see *Railroad Gazette*, April 13, 1900, p. 236.

The curves on Fig. 3 show this. They have, however, been developed theoretically on a basis of adiabatic expansion; that all the energy of the steam between the limits of pressure, viz., 150 lbs. gage pressure and 26-in. vacuum, has been converted into velocity, and that there are no losses due to skin friction, or through loss of pressure by low co-efficient of efflux. This co-efficient of efflux is a feature of the entrance to the nozzle and varies from 50 per cent. in an orifice in a thin plate to 98 per cent. in a well rounded orifice, as shown. The pressure curve is an adiabatic expansion line from the throat to the outlet, and the pressure of the throat .56 times the absolute pressure of the steam before entering the nozzle. The velocity at the mouth of the nozzle is shown to be 3,810 ft. per second and 982 lbs. of steam passing per hour; diameter of throat .4 in.; theoretical h.p., 111.5.

In actual practice as much steam as this could not be made to pass for the reasons just given, so the nozzle would require some modification in consequence. In these investigations allowance must be made for the area of

the searching tube. Fig. 4 shows an actual example of a nozzle designed for discharging into vacuum, but used for discharging into atmospheric pressure, and shows how the steam reaches near the condition of vacuum near the outlet and afterwards rises to the exhaust pressure.

In the De Laval turbine the nozzles are set at an angle of 20 deg. with the plane of motion of the buckets, which is as acute an angle as is possible. The action of the steam on the buckets may be shown by the diagram of parallelogram of velocities, Fig. 6, an ideal condition which could seldom be obtained in practice.

V is the direction and velocity of the steam issuing from the nozzle.

V_0 the velocity and direction of the buckets.

Component V_1 is the relative angle and velocity with which the steam strikes the bucket.

V_2 is the relative direction and velocity of the steam leaving the buckets.

V_3 is therefore the absolute direction and velocity of the steam leaving the buckets.

It will be observed here that V_1 is a horizontal line, so that the combination is one of maximum efficiency, the only losses being due to the angularity of the nozzle.

By reason of the tremendous velocities of steam, a diagram similar to Fig. 7 is what is generally obtained in practice. It will be noted that the angle of the bucket at the entrance corresponds with that of the component V_1 . It is usual to have the angle of outlet making an angle with the plane of motion equal to that of the inlet with the same plane, thus taking away practically all end thrust. These turbines are essentially of very high speed. The smaller sizes run about 30,000 r. p. m. and are geared down to about 3,000; the larger sizes about 10,000 r. p. m. The peripheral speed of the wheel is usually from 600 to 1,200 ft. per second. The reduction of speed is accomplished by means of a pair of helical spur gears with the angle of helix 45 deg.

These gears form by far the biggest part of the whole outfit. The regulation is effected by means of a fly-ball

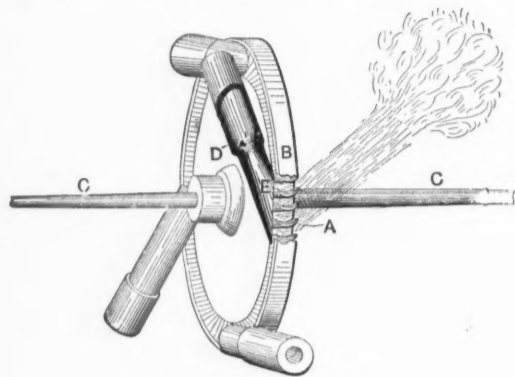


Fig. 1.—A De Laval Turbine.

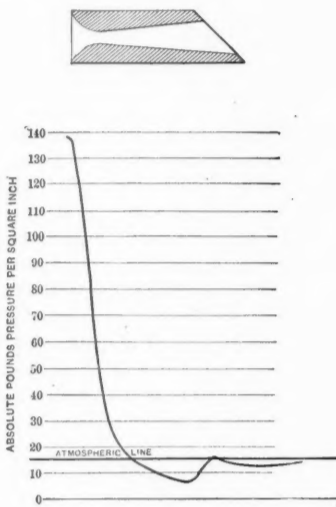


Fig. 4.—Nozzle for Discharging Into Vacuum.

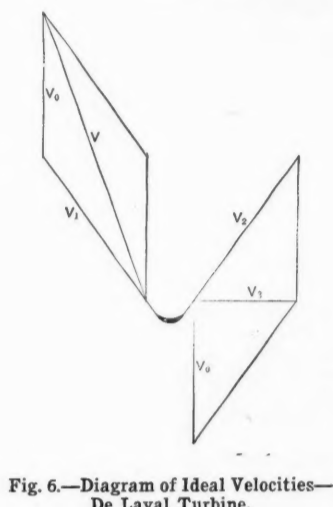


Fig. 6.—Diagram of Ideal Velocities—De Laval Turbine.

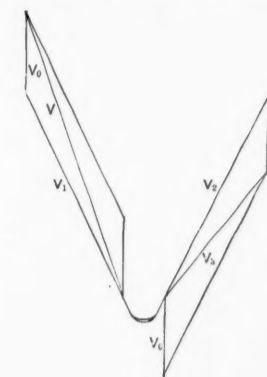


Fig. 7.—Diagram of Practical Velocities Generally Obtained.

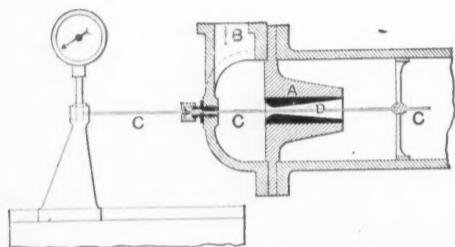


Fig. 2.—Apparatus for Testing Steam Nozzles.

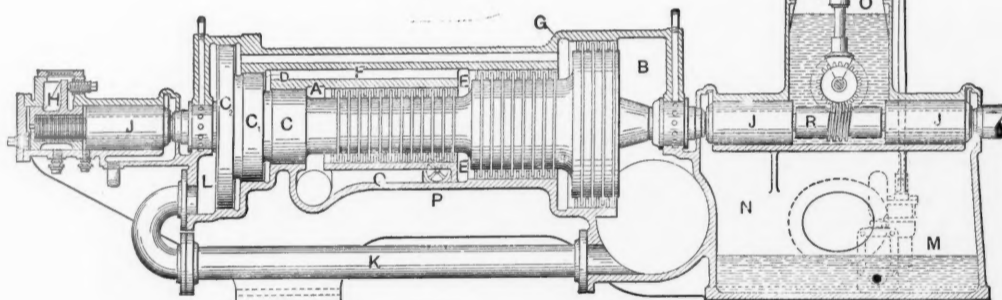


Fig. 8.—Westinghouse-Parsons Steam Turbine—Longitudinal Section.

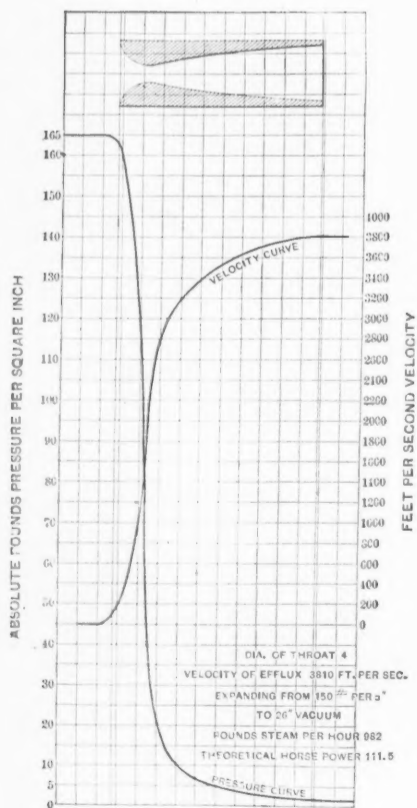


Fig. 3.—Pressure and Velocity Curves.



Fig. 10.—Bearings of Westinghouse-Parsons Steam Turbine.

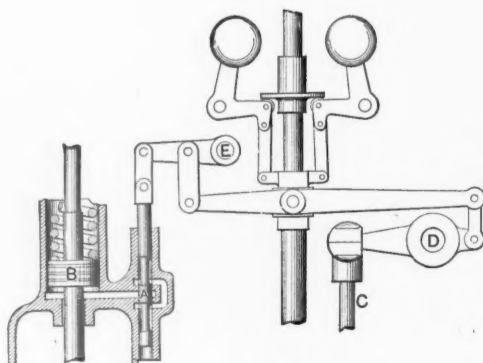


Fig. 12.—Arrangement of Governor Levers.

THE DEVELOPMENT OF THE STEAM TURBINE.

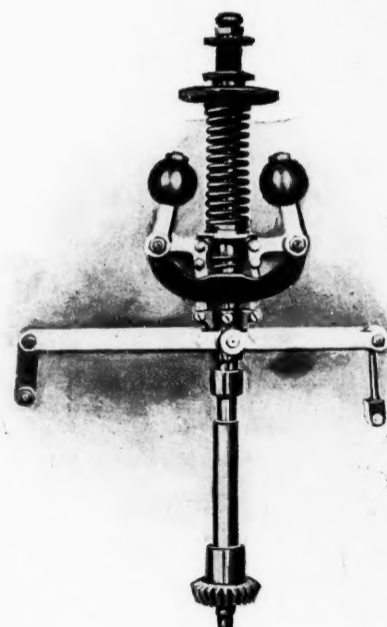


Fig. 11.—Governor of Westinghouse-Parsons Steam Turbine.

governor which is on the slower running shaft and wire-draws the steam at the admission.

Some tests of a 10 h. p. turbine were communicated to the A. S. M. E. in 1895, in which the turbine described had four nozzles of .138 diameter and one of .157 diameter of throat. The nozzles were 2 in. long from throat to outlet. The speed of the turbine was 23,771 r. p. m. reduced by gearing to 2,400; the economy full load, non-condensing, was 47.8 lbs. per h. p. This economy is by no means bad when the small power of the outfit is considered. In December, 1899, some tests were made in France, under the following conditions: 192 lbs. boiler pressure, with 69 deg. F. of superheat, mean h. p. 307.8; r. p. m., 772. The consumption of steam was 13.92 per effective h. p.

The first Parsons steam turbine and generator was built in 1884. It developed 10 h. p. at 18,000 r. p. m. It ran for several years in Gateshead-on-Tyne, England, supplying current for the manufacture of incandescent lamps. It is now in the South Kensington Museum. It consisted of two groups of 15 turbines each, the steam enter-

ing between them and passing in opposite directions through each group. Fig. 8 is a general longitudinal section through a Westinghouse-Parsons steam turbine. The steam enters at the governor valve and arrives at the chamber A, and passes out to the right through the turbine blades, eventually arriving at the exhaust chamber B. The blades are shown in Fig. 15, the steam passing first a set of stationary blades and impinging on the moving blades driving them around and so on. The areas of the passages increase progressively in volume, corresponding with the expansion of the steam. They will, however, be described more fully later. On the left of the steam inlet, Fig. 8, are shown revolving balance pistons C, C₁ and C₂, one corresponding to each of the cylinders in the turbine, which, according to size, may be 1, 2, 3 or 4 in number. The steam at A presses against the turbine and goes through, doing work. It also presses in the reverse direction, but cannot pass the piston C; but at the same time the pressure, so far as the steam at A is concerned, is equal and opposite, so that the shaft is not subjected to any end

thrust. The pressure D is equal to that at E by reason of the balance port F, so, similarly, so far as the steam pressure at E is concerned, there is no end thrust. This same fact also applies to G.

The area of the balance pistons is so arranged that no matter what the load may be, or what the steam pressure or exhaust pressure may be, the correct balance is preserved and the shaft has no end thrust whatsoever. At H is shown a thrust bearing, which, however, has no thrust to take care of, but serves to maintain the correct adjustment of the balance pistons.

The thrust bearing is in two halves, the lower half capable of adjustment in one direction, the upper one in the reverse. The balance pistons never come in mechanical contact with the cylinder, and consequently there is no friction. The thrust bearing has ample surface, and besides is subjected to forced lubrication and does not wear. The adjustments once made remain good.

At K, Fig. 8, is a pipe connecting the back of the balance pistons at L with the exhaust chamber, to insure the pressure at this point being exactly the same as that of the exhaust.

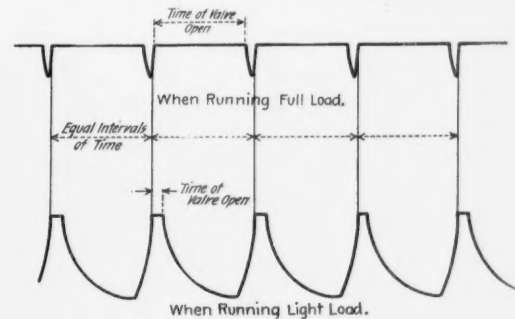
At J are shown the bearings. They are also shown separately in Fig. 10. The bearing proper is a gun metal sleeve, which is prevented from turning, by a loose-fitting dowel. Outside of this are three concentric tubes having a small clearance between them. This clearance fills up with oil and permits a vibration of the inner shell, at the same time restraining same. The shaft, therefore, revolves about its axis of gravity instead of the geometric axis as would be the case were the bearing of everyday construction. The journal is thus permitted to run slightly eccentric, according as the shaft may be out of balance. This form of bearing performs the functions of De Laval's slender flexible shaft, but in this case the shaft is built as rigidly as possible. At R, Fig. 8, is shown a flexible coupling by means of which the power of the turbine is transmitted.

A by-pass valve is provided, shown at P, which admits high-pressure steam by means of port Q to the steam space E. By opening this valve as much as 60 per cent. overload may be obtained, and with turbines operating condensing, full load may be obtained should the condenser be inoperative, and the turbine exhaust into atmosphere.

A fly-ball governor is used, as shown in Fig. 11. The ball levers are swung on knife edges. The governor works both ways; that is to say, the midposition of the levers is admitting a full head of steam to the turbine. A movement from this in either direction is tending to cut off the supply. This serves a useful purpose in the event of very excessive load coming on the turbine, such as a short circuit, which has the effect of bringing down the speed more than the percentage variation permitted by the adjustment of the spring when the steam immediately becomes shut off. Again, in such an event as some of the governor-driving mechanism becoming broken and the governor balls slowing up independently of the turbine, the steam is shut off before any damage could take place.

The speed of the turbine may be varied within all the limits of the governor spring while the turbine is running. This is particularly useful in bringing alternations in synchronism and adjusting their differences of load when in multiple. This is accomplished by grasping the top knurled head, when, by means of a ball-bearing shown, the spring and tension nuts remain stationary. Any adjustment of the spring nuts may then be made, without disturbing the running of the turbine.

The arrangement of the governor levers is shown in Fig. 12. They are attached to a small relay valve A, which controls steam below the piston B, which is directly connected to the main admission valve. The levers receive reciprocating motion at C from an eccentric, and use the governor clutch as a fulcrum, points D and E being fixed. Continuous reciprocating motion is thus given to the relay valve. This is in turn transmitted to the admission valve. The function of the governor is to vary the plane of oscillation of the relay valve, which causes the admission valve to remain open for a longer or shorter period according to the position of the governor. The steam, therefore, is admitted to the turbine in puffs, which occur at constant intervals of time. The puffs are either of long or short duration, according to the load. At full load the puffs merge into an almost continuous blast. If we were to attach an indicator to the steam space A, Fig. 8, and pull the drum around by hand, we should produce a series of cards similar to those here shown:



This does not mean that in the latter case there is a more complete expansion of steam than in the former, but that high-pressure steam is made use of at all loads.

There is absolutely no variation of angular velocity in

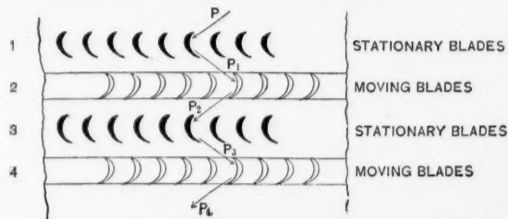


Fig. 15.—Blades of Westinghouse-Parsons Steam Turbine.

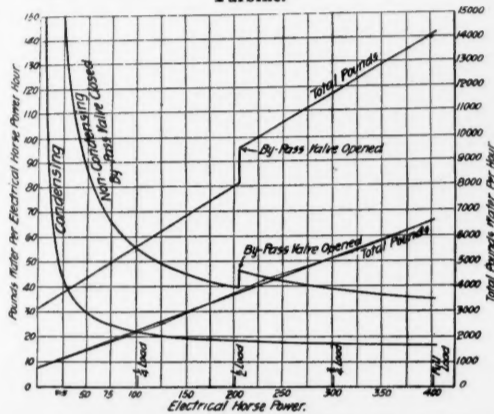


Fig. 16.—Economy Curves of a 300 K. W. Westinghouse-Parsons Steam Turbine.

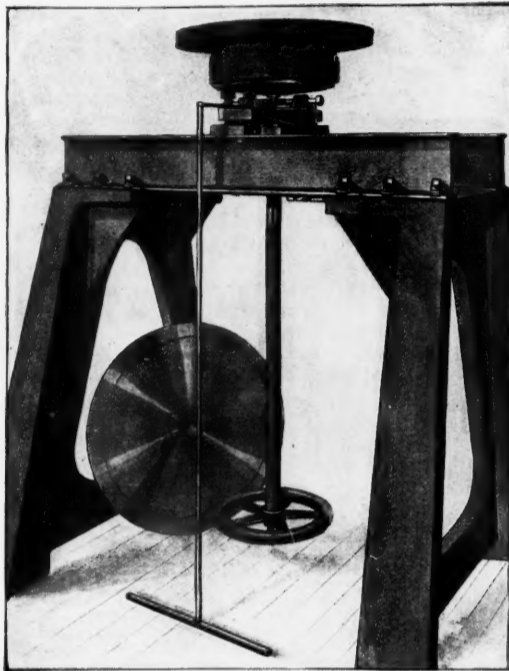


Fig. 22.—Westinghouse Device for Balancing Revolving Parts.

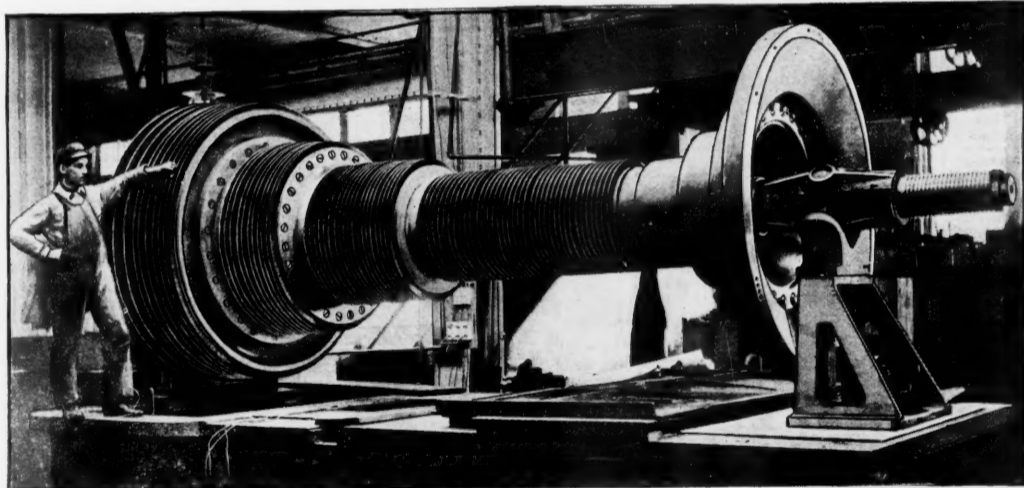


Fig. 20.—Complete Revolving Part of 3,000 H. P. Turbine.

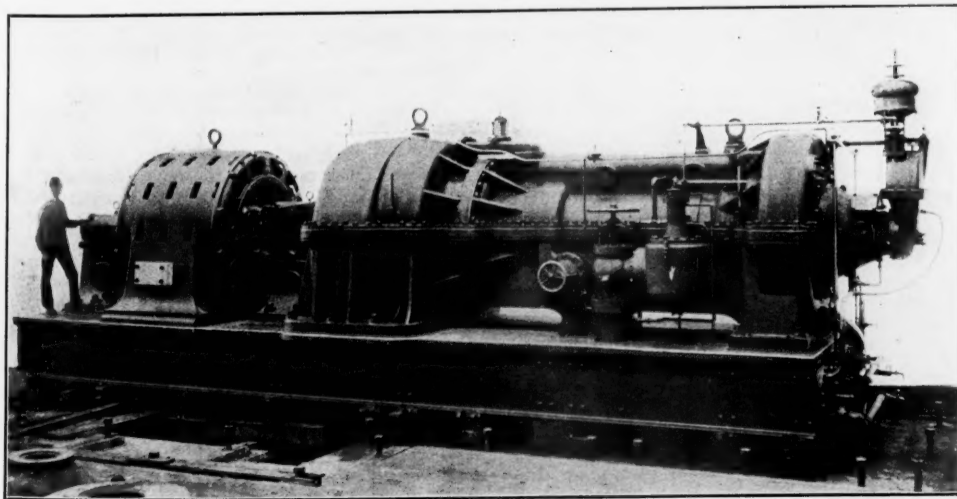


Fig. 21.—Turbine Being Placed in Power House of Hartford Electric Light Co.
THE DEVELOPMENT OF THE STEAM TURBINE.

the turbine, which is necessarily present in reciprocating engines, hence the value of turbines for running alternators in multiple. This can be realized when we know a 500 h.p. turbine will run 20 minutes after the throttle has been closed. This, of course, speaks well for the low friction, but is principally due to the tremendous fly-wheel effect of the shaft. Mr. Parsons made very successful use of an electrical governor which was attached to a relay valve working in exactly the same manner as just described.

Referring to diagram, Fig. 15, the steam at pressure P in expanding, through row 1, to pressure P_1 , converts its energy into velocity and impinges upon the moving blades, row 2. The steam then performs a second expansion in expanding through row 2, again converting its energy into velocity, but this time the energy of the efflux is to react upon the blades from which the steam issues. The same cycle is repeated in 3 and 4, and so on until exhaust pressure is reached. The moving blades therefore receive motion from two causes, the one due to the impact of steam striking them, the other due to the reaction of the steam leaving them, and in this respect this turbine is a combination of Bianca's wheel and Hero's engine. In the Parsons turbine the velocities of steam never exceed 500 to 600 ft. per second, and for the most part are considerably less than this.

It may be interesting to record the actual pressure exerted on individual blades in a turbine. Take, for example, one of 300 k.w. capacity, to which special reference will be made. There are altogether 31,073 blades in the turbine, of which 16,095 are moving blades. The pressure that each of them exerts in revolving the shaft varies from .89 to 1.04 ounces.

The diagram, Fig. 16, shows some economy curves developed from tests made on one of the 300-k.w. turbines now in operation at the Westinghouse Air Brake Company's Works. The results may be summarized as follows: Full load, 16.4 lbs. steam per e.h.p. hour; three-quarters load, 17 lbs. steam per e.h.p. hour; one-half load, 18.2 lbs. steam per e.h.p. hour; one-quarter load, 22 lbs. steam per e.h.p. hour; running light, 750 lbs. per hour; vacuum, 26 in. to 27 in.; boiler pressure, 125 lbs. per sq. in.; r.p.m., 3,600. The consumption of 16.4 lbs. at full load is in itself remarkable, but such results as at the light loads have never been approached before. It may be said that the consumption at half load is only 10 to 12 per cent. greater than at full load. It should not be lost sight of that these results are per electrical horsepower.

To make a comparison with a reciprocating engine and assume the efficiency of transmission from the steam cylinders to the switchboard to be 85 per cent., which is about the very highest attainable, would bring the full-load water rate on the turbine just described to 14 lbs. per i.h.p. The tests were made under ordinary conditions so far as dryness of steam is concerned, the boilers being some distance away, and no allowance made for wetness of steam.

On the curves are shown the efficiency when running non-condensing. These results are somewhat inferior, as this turbine was designed for condensing. A turbine designed for running non-condensing gives proportionately as good results as the condensing curves shown on the diagram. By this set of curves may be observed the function of the by-pass valve, how, when running non-condensing, the by-pass valve remained closed until about half load was reached. Upon being opened the efficiency fell off, as shown, and continued to improve from there on as the load increased. The overload capacity of the engine is obviously more flexible than that of most engines. Superheating may be made use of with considerable gain in economy and without difficulty. In this connection Prof. Thurston has lately recorded some experiments with a De Laval turbine. For every 3 deg. F. of superheat 1 per cent. of gain in economy was attained. With 37 deg. of superheat the capacity of the turbine was doubled. This gain he attributes almost entirely to the reduction of skin friction.

The practical efficiency of a turbine power plant may be gathered by some tests made by the Westinghouse Air Brake Co. After the plant had been installed some nine months the whole plant was shut down, and the steam engines which had been previously doing the work were connected up again, put in service and were kept running a week, with careful records of fuel and water taken. Similar tests were made with the turbines and electrical transmission. The saving in coal averaged 35.7 per cent. during the day and 36.4 per cent. during the night in favor of the turbines. The saving in feed water averaged 29.8 per cent. during the day and 41.4 per cent. during the night. In round numbers this means a saving of 40,000 lbs. of coal in 24 hours. The gain is in great measure due to the economy of the turbines, but also to some extent to the elimination of the condensation in long lengths of steam pipe and to the advantages of electrical transmission.

The whole plant, three turbines and generators, aggregating 1,500 h.p., occupies a floor space 24 ft. square. The turbine and generator, as shown in the *Railroad Gazette*, April 13, weighs about 25,000 lbs.; total length, 19 ft.; width 4 ft. 3 in.

Lately a 1,000-k.w. outfit has been built by C. A. Parsons & Co., for the Ellersfeld Corporation, in Germany. At 1,200 k.w., 130 lbs. boiler pressure, 18 deg. F. of superheat, the turbine driving its own air pump, etc., an electrical horsepower was produced for 14.025 lbs. This is probably the highest economy ever attained in any steam engine.

Fig. 20 shows the complete revolving part of a 3,000-

h.p. turbine. Its weight is 28,000 lbs.; length over all, 19 ft. 8 in.; 12 ft. 3 in. between bearings; the largest diameter 6 ft. The turbine of which this forms a part is shown on Fig. 21 and is being set up in the powerhouse of the Hartford Electric Light Co. It is direct-connected to a 1,500-k.w. generator, the total outfit being 33 ft. 3 in. long, 8 ft. 9 in. wide, 175,000 lbs. total weight, including generator. This is the largest steam turbine in one integral part ever built.

The cost of renewals and repairs is very small. In 1897 the Newcastle & District Electric Lighting Co. published costs. The powerhouse contained 11 turbines of 75 to 150 k.w. each. The cost for repairs and renewals amounted to .26 cents per k.w. per annum, and included all repairs to boilers, turbines, condensers, pumps, generators, cables and fittings.

In balancing revolving parts it is found best to use comparatively narrow rings and balance each separately. For this work the Westinghouse Machine Company has made a machine that gives great accuracy. It is shown in Fig. 22, where a ring is in place on the turntable. The turntable is pivoted on a beam which is in turn hung on two knife edges. Below the turntable is rigidly attached an adjustable counterweight. The turntable is free to turn independently of all this. Means are provided to slide the whole turntable and counterweight in the beam and in a direction at right angles to the line of the knife edges. The counterweight is adjusted to bring the combined center of gravity in a plane close to the knife edges. By sliding the mass in the beam, the table may be made to rest horizontally. Then by giving the turntable one-half revolution the table will fall over by twice the amount it is out of balance. Readings are taken in two opposite directions and the exact location and the amount of the error is figured.

Balancing by this method is done rapidly. A ring weighing 6,000 lbs. has been balanced within 2 ozs., and rings weighing 200 or 300 lbs., within $\frac{1}{8}$ oz. In the case, however, of the revolving parts of electric generators the final winding, etc., is liable to throw it out of balance,

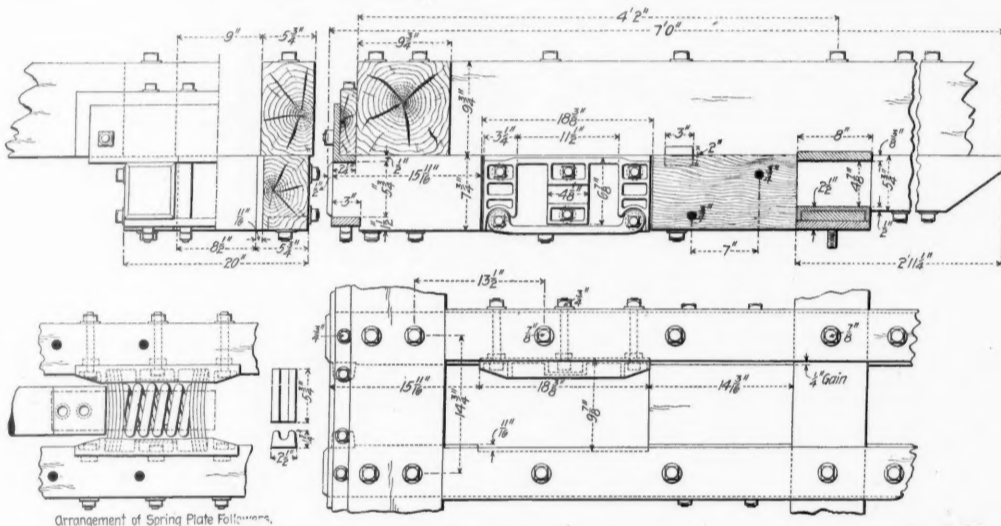
The surplus shown in the final report for the preceding year was \$53,064,877.

The amount of dividends stated does not include the dividends paid to stockholders by railroads which are operated under lease or some other form of control.

Draft Gear of the Duluth, Missabe & Northern.

Mr. Wm. Smith, Superintendent of Motive Power of the Duluth, Missabe & Northern, has furnished us drawings of and information about the draft gear used on recent heavy cars of that road, on which the trains are probably as heavy as on any in the country. The accompanying engraving shows the draft timbers and attachments for ore cars. It may be seen that the Hinson attachments are used, where each of the ordinary follower plates is replaced by four steel springs, which are $5\frac{1}{2}$ in. wide, $8\frac{1}{2}$ in. long and 5-16 in. thick. These spring plates have a set of $\frac{3}{8}$ in. One set of double-coil springs is used in connection with the M. C. B. yoke, which is made of 1 in. x 4 in. wrought iron. On cars recently built skeleton bolsters that permit the draft timbers to pass back through the bolster to any point desired are used. A solid block is put between the draft timbers, extending from the check castings to the body bolster.

This rigging has been in use on the Duluth, Missabe & Northern for three years. During the first year it was put on 400 cars, the second year on 500, and last year 800 cars were equipped, making 1,700 in all. Mr. Smith says that never yet has he found what might be termed an entire follower broken. In all, about half a dozen of the spring plates have broken, but never more than one plate in any one follower has been broken at a time, and those were replaced at once. The breakage of coil springs is not decreased, as many coil springs being broken with the spring follower plates as were broken with the solid followers formerly used. As said, the follower plates have $\frac{3}{8}$ in. set, and a tremendous compression is required to close them, so that in starting the heavy trains there is



Draft Gear for Ore Cars—Duluth, Missabe & Northern.

and then there is no alternative but to balance it in its entirety.

The paper closes with a brief review of the dimensions, equipment and operation of the English boats, "Turbina" and "Viper." The successive stages of their equipment and the important changes that it was found necessary to make are recited with interesting comment by the author. It is stated finally that while it is generally conceded by engineers that little more may be anticipated in the development of reciprocating engines, the turbine is capable of development in many ways, and particularly in the use of superheated steam.

Interstate Commerce Income Report for Year to June 30, 1900.

The preliminary report on the income account of railroads in the United States for the year ending June 30, 1900, prepared by the statistician to the Interstate Commerce Commission, contains returns of operating companies representing 190,406 miles of line.

The gross earnings of the roads included in this report were \$1,480,673,054, or \$7.776 per mile of line. Of these earnings \$396,860,760 were passenger and \$1,083,812,293 freight. The gross earnings shown in the final report for the preceding year were \$1,313,610,118. Operating expenses for the last fiscal year aggregated \$856,814,142, or \$5.025 per mile of line. The net earnings of the roads embraced in this advance report were \$523,858,912, or \$3.710,747 more than they were for 1899. Income from investments, etc., amounted to \$60,675,700; total income, \$584,534,612.

The total deductions from income were \$395,811,056. This includes interest on bonds, rents for leased lines, taxes (\$44,396,165), and other charges to income. The amount of dividends declared was \$109,400,147, which is \$27,555,388 greater than by corresponding roads for 1899. The resulting surplus from the operation of the roads covered by this preliminary report was \$79,323,409.

never the sudden and severe stress on the draft rigging that is given with the old-style followers. With the heaviest trains, there is said to be enough spring in the followers to cushion the shock, and this is held to account for the better performance of the draft rigging. When the old-style follower was used the draft timbers suffered severely, whereas with the present arrangement there has been very little trouble with draft timbers, excepting where short timbers were used with solid body bolsters.

In all the latest cars having skeleton body bolsters, and any length of draft timber desired, there has been no trouble with the draft rigging. In exceptional cases where the timbers were not sound, they have been pulled apart, and also in some instances the rear ends of coupler yokes have been pulled out. In general the results with this rigging have been very satisfactory in heavy service.

The Proposed National Standardizing Bureau.

Under the direction of the Secretary of the Treasury a bill to establish a national laboratory with the above title was prepared and sent to the House of Representatives last April. It was referred to the Committee on Coinage, Weights and Measures, and early in May at a hearing before that committee received the unqualified indorsement of all who were present to represent the scientific and commercial interests of the country. Among those who gave evidence in favor of the proposed bureau were Hon. Lyman J. Gage, Secretary of the Treasury; Dr. Henry S. Pritchett, then Superintendent of the Coast and Geodetic Survey, now President Massachusetts Institute of Technology; Dr. William McMurtrie, President of the American Chemical Society; Dr. A. E. Kennelly, President of the American Institute of Electrical Engineers; Capt. C. D. Sigsbee, U. S. N.; Mr. Henry Ives Cobb (architect), and others. Letters indorsing the bill were also received from many universities, technical societies and schools; from the different scientific departments of the government, from Mr. George Westing-

house, Dr. C. B. Dudley, Chief Chemist of the Pennsylvania railroad and others. The committee unanimously reported in favor of the proposed bureau, but owing to the close of the session it was impossible to get the bill before the House.

An effort is now being made by the Secretary of the Treasury and others interested in weights and measures to have the bill considered early this session. An identical bill has been introduced in the Senate and referred to the Committee on Commerce. This committee has the measure under consideration and will no doubt report upon it in the near future.

The plan proposed is to extend the equipment, functions and personnel of the present office of Standard Weights and Measures, which is under the Treasury Department, until it shall fill the place in this country occupied in Germany by the Physikalische-Technische Reichsanstalt, which was established in 1887 at a cost of over \$1,000,000. The bill provides an appropriation of \$250,000 for a laboratory, \$35,000 for its furnishings and equipment, \$25,000 for a site, and the necessary amounts for salaries for a director, physicists, chemists and the required staff of laboratory assistants. The total appropriation is a small one compared with the amounts expended in establishing and maintaining similar laboratories abroad, or the benefits to be derived from such an institution.

Among the functions of the proposed bureau are: The comparison of the standards used in scientific investigations, engineering, manufacturing, commercial and educational institutions, with the standards adopted or recognized by the Government; the testing and calibration of standard measuring apparatus; the determination of physical constants and the properties of materials when such data are important to scientific or manufacturing interests and cannot be obtained of sufficient accuracy elsewhere. The proposed bureau will exercise its functions for the Government of the United States; for any state or municipality, or for any scientific society, educational institution, firm, corporation or individual in the United States engaged in manufacturing or other work requiring the use of standards or standard measuring instruments.

The German Reichsanstalt before mentioned, which has been copied by England and France, is of great value to makers of all kinds of instruments of precision as well as to manufacturers in general, and is said to have largely increased the export of such instruments from Germany, which has trebled in ten years. The value of such a bureau will be apparent at once to readers of the *Railroad Gazette*, many of whom have suffered the delay and inconvenience of sending instruments abroad for testing and calibration.

It is thought that if members of technical and engineering societies, prominent manufacturers, mechanical and electrical interests, take the interest which the importance of the matter demands, and will not let senators and members forget it in the press of other matters, the bill can be passed during the present session of Congress; otherwise it will be delayed for at least another year. When the advantages to be gained are considered the cost seems insignificant, and there seems to be no reason why anyone should oppose the bill. The total amounts now appropriated annually by different governments for standardizing purposes are as follows:

Germany	\$116,000
England	62,100
Austria	46,000
Russia	17,500
United States.....	10,400

Foreign Railroad Notes.

The two great lines from London to Scotland, the East Coast and the West Coast, have shortened the schedules of their fastest trains about 15 minutes; but for the first three days the East Coast Line lost time north of York and the train reached its destination several minutes late, in one case 28 minutes. The West Coast line got in several minutes ahead of time.

On the Continent of Europe they still have a time convention. That to consider the time-tables for this winter was held at Palermo, Dec. 5, 170 delegates being present.

Heating System of the Clinton Roundhouse.

A plan and elevations of the new Chicago & Northwestern 50-stall roundhouse at Clinton, Iowa, were shown in our issue of Sept. 7. At that time we were unable to give the arrangement of heating and ventilating apparatus, which is one of the interesting features of the

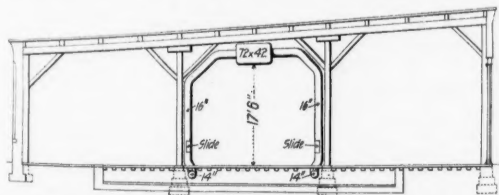


Fig. 3.—Clinton Roundhouse—Section at A-B.

building. This part of the work is now illustrated. Since the roundhouse was built the B. F. Sturtevant Co. has put in this apparatus, and has similarly equipped another roundhouse for the Northwestern, as well as new roundhouses on several other roads. This system of heating

as applied to roundhouses seems to be meeting with general favor, and the installation at Clinton may be taken as a good example of it.

Referring to Fig. 1, it may be seen that the heater and fan are in a small building between the machine shop and roundhouse, close to the boiler and engine room. This location reduces the piping as much as possible. The fan is 12 ft. in diam. and is driven by a 10-in. x 12-in. engine,

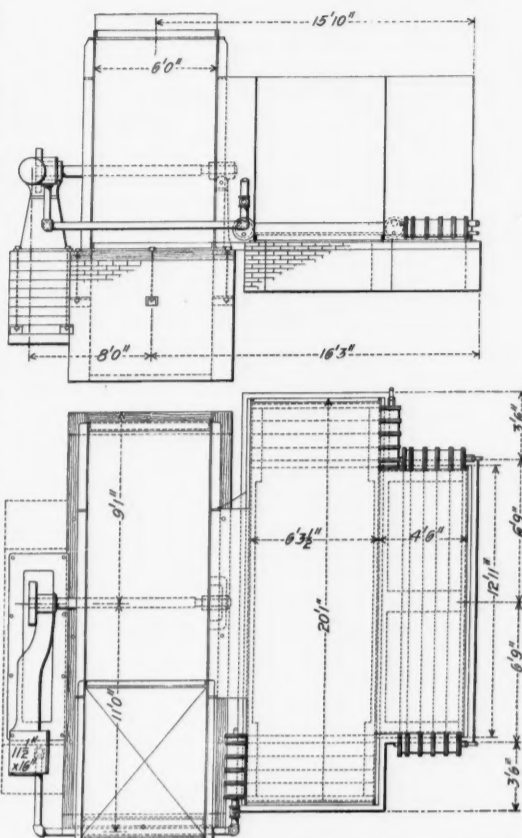
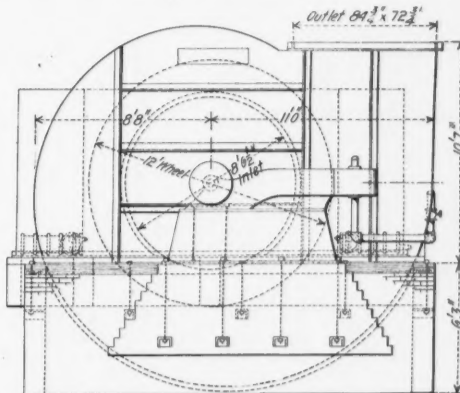


Fig. 2.—Diagram of Engine, Fan, and Heater—Clinton Roundhouse.

direct-connected to the fan shaft. The diagram, Fig. 2, shows these relations. The entering air, before reaching the fan, is heated while passing between coils of steam pipe, the capacity of the heater being the equivalent in volume of 20,000 lineal ft. of 1-in. pipe. The connections are so made that the exhaust steam from the fan engine, machine shop engine, air compressors and pumps

is used in the heating coils, and if, on account of an unusual demand, this supply is not sufficient, live steam can be admitted from the boiler through a reducing valve. With low-pressure steam, the air from the fan can be heated from 140 to 170 deg. F., when the fan is running at about 138 r. p. m.

It may be seen that the main conduit, which is galvanized iron, is 84 in. x 60 in. as it comes from the fan.



This conduit is divided into two branches, each of which extends half way around the house and is carried overhead. These main branch pipes at the beginning are 72 in. x 42 in. and are gradually reduced in size, becoming round ducts 20 in. in diam. at the extremes. Between successive pairs of pits, two 16-in. galvanized iron pipes are brought down alongside the supporting posts, as shown in Fig. 3. These pipes join lines of 14-in. sewer pipe, which are placed underground. The underground pipes extend through the side walls of opposite pits, so that the hot air is delivered directly below and toward either end of an engine standing over a pit. This arrangement quickly thaws engines in winter.

There are several other advantages over the common method of placing steam pipes along the sides of the pits. As the air ducts are all concealed and thus protected from drip in thawing out engines there is no corrosion as where steam pipes are put in the pits, and water falls on them. The air can also be regulated so as to facilitate working about engines. When work is to be done in the pit the hot air supply can be suited to the need by using the dampers in the mouth of the hot air pipes. These dampers are set into the floor as shown in details of Fig. 1. Slides in the vertical branch pipes permit of hot air being admitted into the house, above the floor, when desired. Some additional advantages of the hot air system are that the ventilation of the house is positive and that steam pipes are closely assembled, and there is no danger of pipes freezing. The plant apparatus is controlled by one man and is easy to regulate and care for.

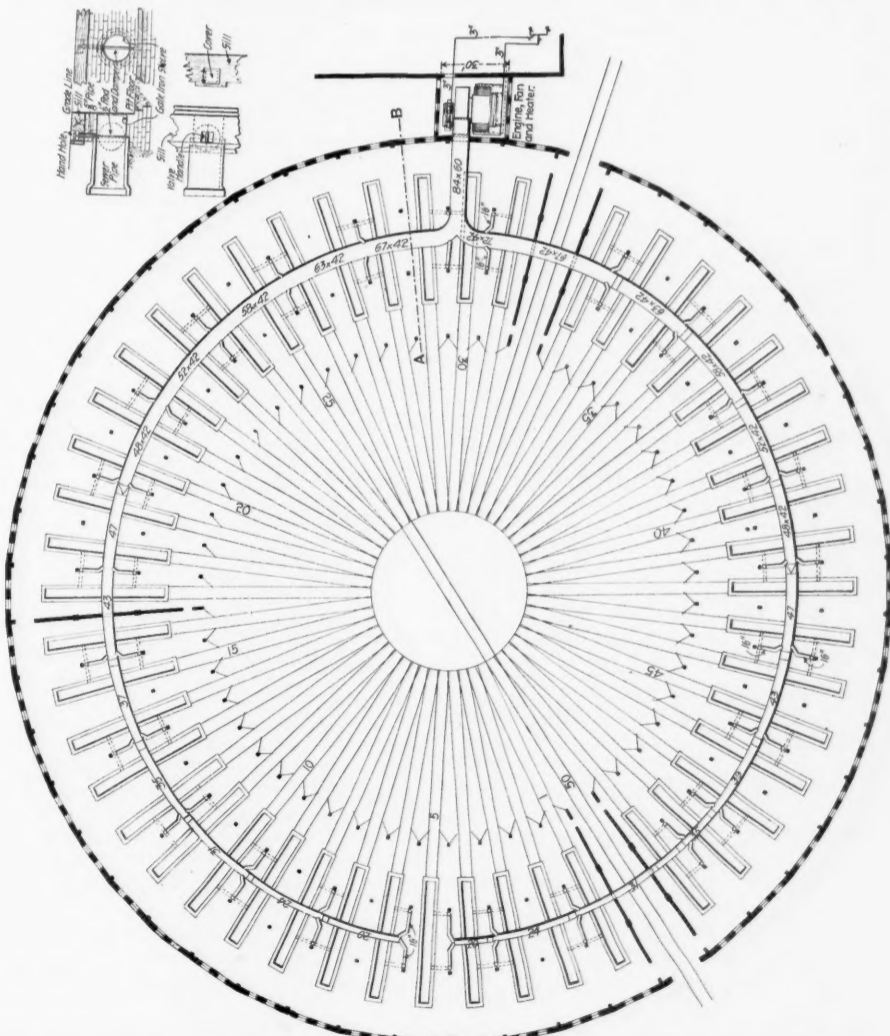


Fig. 1.—Plan of Heating Clinton Roundhouse—Chicago & Northwestern Railroad.



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EDITORIAL ANNOUNCEMENTS.

CONTRIBUTIONS—Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies in their management, particulars as to the business of the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and railroads, and suggestions as to its improvement. Discussion of subjects pertaining to all departments of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.

ADVERTISEMENTS—We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay, EXCEPT IN THE ADVERTISING COLUMNS. We give in our editorial columns OUR OWN opinions, and these only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers, can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially either for money or in consideration of advertising patronage.

The month of October for the first time this year shows a loss in both gross and net earnings for the railroads of the United States. *The Chronicle's* figures covering 137 roads show a decrease in gross earnings for the month of \$373,000, and in net earnings of \$976,000. It is to be noted that these figures follow very heavy increases of a year ago, amounting to \$12,275,000 gross, and \$4,618,000 net earnings, but notwithstanding the heavy increase of a year ago, the roads this year would undoubtedly have shown a fair increase had it not been for the coal strike. The eight anthracite roads dropped in net earnings from \$3,213,000 in 1899, to \$212,000 in 1900, a loss of over \$3,000,000 or 93.4 per cent. The Reading led in the losses of net earnings with \$1,234,000 net; then follow the Lehigh Valley, \$1,053,000; the Central of New Jersey, \$390,000; the Erie, \$314,000. The Canadian Pacific also shows a loss in net earnings of \$390,000. There were some heavy increases in net earnings, including the Pennsylvania Lines East and West, \$438,000; the Atchison, Topeka & Santa Fe, \$283,000; the Southern Pacific, \$259,000, and the Houston & Texas Central, \$221,000. The gains have been particularly heavy in the South and Southwest.

During the year 1900, all the contracting locomotive works in the United States (that is those outside the railroad shops), 15 in number, will have built 3,153 locomotives. This is the largest number ever built in one year and is 680, or 27.5 per cent., more than in 1899, when the record was also broken. In fact, the increase this year will be nearly 14 per cent. greater than the increase of 1899 over 1898. Of the 3,153 locomotives that will have been turned out this year, 545, or more than 17 per cent., will be compounds. In 1899 the output of compound locomotives was 339, or nearly 14 per cent. of the total output; and in 1898 the number of compounds was 373, or 20 per cent., of the total. The figures for the year include 102 geared locomotives and 21 compressed air and 48 electric locomotives. The number of locomotives that will have been built for export this year is 505, or about 16 per cent. of the total output. This is nine, or not quite two per cent., less than in 1899, when 514 engines were built for railroads in foreign countries. In 1898, 554, or 30 per cent. of the total, were sent abroad; and in 1897, 386, or 31 per cent. In 1896, 309, or 26 per cent., were exported. The following table shows the total number of locomotives built each year for the past 10 years:

1900	3,153	1894	695
1899	2,473	1893	2,011
1898	1,875	1892	2,012
1897	1,251	1891	2,165
1896	1,175	1890	2,240
1895	1,101	1889	1,890

At present the outlook is that 1901 will at least equal 1900. Some of the locomotive builders have orders

enough on their books to keep their works busy for from five to nine months hence and judging from our news columns there is no immediate prospect that the demands of the railroads for new motive power will be less than a year ago.

The total number of cars that will have been built by the car building works in the United States during 1900 is 124,106. This of course does not include the cars built by the railroads in their shops. Of the 124,106 cars, 113,070 are freight, 1,515 passenger, and 6,091 street cars for use in America; and 2,561 freight, 121 passenger, and 748 street cars for export. All of these figures are official, except in the case of a few small builders, the output of which we have carefully estimated. Last year the total output of these same works was 123,893 cars, divided as follows: 117,982 freight, 1,201 passenger, and 4,710 street cars for use here; and 1,904 freight, 104 passenger, and 296 street cars for export. The extension of the steel car industry is shown by the fact that of the total freight cars that will have been turned out this year, 14,464 were all steel; 447 of these were for export. Last year, the total was 10,500, while in 1898 but 2,700 were built. In addition, 4,140 of the wooden freight cars, for domestic use, had steel underframes. During the coming year we may expect to see a still greater increase in the use of steel cars, as the Pressed Steel Car Co. already has orders in hand for several thousand steel cars not included in this year's output, and four other concerns have lately entered actively into the work of building steel cars. More cars for passenger service will probably be built in 1901 than in 1900, judging from the present activity in that direction.

The *St. Louis Globe Democrat* which appears to have seen the official report of the proceedings of the recent conference of western railroad presidents in New York City, says that at that conference a resolution was adopted looking to the organization of a committee of railroad presidents, from all sections of the country, to try to come to an agreement with the Interstate Commerce Commission on a bill for the amendment of the Interstate Commerce law. The preamble recites that under the anti-trust act of 1890 railroad conferences are unlawful; that such conferences are necessary to keep rates stable, and that the Interstate Commerce law requires stability; that amendatory legislation cannot be accomplished except by the co-operation of the Interstate Commerce Commission and that, therefore, such co-operation must be sought by making concessions. Messrs. Hughitt, Felton, Ripley, Earling, Burt and Jeffery were requested to undertake the organization of this committee. Whatever may be the result of this action, its spirit is wise. Chairman Knapp, who took the initiative in establishing these presidents' conferences a year ago, appears to have given up in despair (for which we do not blame him). He has not attended the last few conferences, and the reason is pretty obvious. But the need of "co-operation between the Commission and the carriers, through conciliatory and friendly conferences," to quote the language of the presidents' resolution, is as great as ever; and it is certainly fitting that the presidents should now take the initiative. The railroads and the Commission have now pursued an obstructive policy so long that it is pretty evident that each side can continue its present attitude indefinitely; so the only chance for progress is for one side or the other to give in at some point.

The Topeka Tests of Draft Gears.

In writing lately (November 30, p. 794) of Mr. Sanderson's paper on tests of draft gears we permitted this sentence to find its way into our article: "It will be seen that all of the rigging began to fail early in the game." The preceding sentence was: "It should be kept carefully in mind that they were only partially tests of draft-gear," and we had also said that the "trials were designed to test the attachments to the sills for pulling shocks." In the sentence first quoted here we had in mind the riggings tested, considered as a complete draft gear, from the coupler shank back to the draft sills, but failed to express that idea, and the sentence quoted has given offence to several draft gear men, and has perplexed several railroad men. This is quite natural, for the sentence as printed is not strictly true. Within the limits of the tests, so far as concerns the purposes and results

of the tests, only three of the riggings seem to have actually failed as adequate attachments to the sills, and Mr. Sanderson says explicitly: "It was plain that we were able to select three or four gears that were all probably stronger than the framework of the cars; anyhow, they were a long advance on what had been used before, and it left the field open to the purchasing agent to get rival bids from several firms whose product had stood a most severe test successfully. . . . It was further evident that even had we gone on to the utter destruction of each gear . . . each maker would have immediately strengthened up his gear where it showed weakness, and justly claimed that the test made should not condemn his revised design."

Within the limits of the tests and considering their purpose, our statement was wrong. The spirit and intent of the statement were fair, and we wrote (or intended to) in the interest of science; therefore we make no apology for the motive or spirit. The manner of the statement was, however, unjust and it was careless, and a journal like this should never be even a little careless. For that injustice and carelessness we apologize and will gladly make any proper amend to the persons injured.

The carelessness consisted in that we did not express the idea that the deficiency revealed was in the draft riggings, as a whole, not merely as attachments to the sills. We do not appear to have been alone in the thought that taking the riggings as complete draft gears the tests showed that they are, to say the least, inadequate. One Superintendent of Motive Power said, in written discussion of the paper: "Many of the eight nameless draft gears seem to be inferior to the present M. C. B. standard . . . and the results of this test fully demonstrate the necessity of a careful investigation into the draft gear question."

We admit, with pleasure, that the tests showed that "three or four of the gears were all probably stronger than the framework of the cars;" we would admit that six or seven of them might easily be made so.

Now let us consider the assemblage tested, as a whole. As a draft gear it represents everything back of the coupler—everything but the knuckle, coupler head and shank. We find that in one rigging the springs closed solid with a blow of five feet; that in six the springs closed with a 10-foot blow; that in the eighth the stops touched but the springs did not close. Whether or not the springs that closed at 10 ft. would have been closed at nine or eight or seven feet we need not now inquire. But the kinetic energy of the blow of a 1,640-lb. drop falling 10 ft. is equal to the energy of a 34,000-lb. car, loaded with 60,000 lbs., at a little more than 2¼ miles an hour. We shall follow this thought no further. We find that the yokes yielded at various stages and in different ways. These were no part of the gear which the trials were designed to test, but they are part of a complete draft gear and they got tested. Their performance gave some useful lessons. These are some of the things that we had in mind in writing before.

It appears that the officers of the Atchison now expect to make trials of these and other draft gears on long trains, as in actual service, and it will be a fine thing if this can be brought about. Everyone will be disappointed if the two friction gears do not appear in these trials.

To Finish Rails at Low Temperature.

In Mr. Metcalf's remarkable paper on "Steel, its Properties; its Use in Structures and Heavy Guns," read before the American Society of Civil Engineers in 1887, he said: "In every piece of steel that is in existence to-day there is a sure record of the last temperature to which it was subjected, as well as of the manner in which the steel was worked. . . . Every piece of steel is at its best in all physical properties when the grain is in the finest condition possible, or its crystals are the most minute and uniform size. The largest crystals and weakest structure are formed when iron and steel are allowed to cool slowly and in a state of rest, and the finest crystals and the best structure can only be formed by quick cooling and the violent agitation of the hammer or of the rolls." The fact could not be stated better. These sentences stand as classical. The significance of the fact in rail making has been slowly grasped by rail users until it is now very generally understood. It was probably sooner grasped by the rail makers. In the last dozen years we have heard a great deal about the vice of squirting hot rail steel through the rolls and have ourselves ventured to speak of the matter three or four times a year at least.

A few months ago we mentioned the plan then under experiment at the Edgar Thomson Works of

the Carnegie Company. This plan has now been put in use there and by it all rails made there will be finished. It consists essentially in introducing, between the intermediate rolls and the finishing train, a cooling bed on which a number of rails will accumulate and over which they will travel. The time taken to pass over this bed will be sufficient to reduce the temperature by the required amount. Just what this reduction is we are not informed. It will be apparent at once that there will be no loss of output and that the delivery at the end of the finishing train will be exactly the same as if no rails passed over the new bed. The only delay will be the time necessary to fill this bed at the start.

The plan was invented by Mr. Julian Kennedy, Consulting Engineer at Pittsburgh, and Mr. Thomas Morrison, General Superintendent of the Edgar Thomson Works. The mills were closed for about three weeks in order to put in the new machinery and were started up again December 5. The finishing rolls had to be torn down and moved with their engine some 56 ft. further down the mill and 8 ft. out of the line of the intermediate rolls. The hot saws, hotbeds and other plant had also to be moved 56 ft., involving, of course, new foundations and a new building 78 x 71 ft. to cover the new hotbeds, etc. The rail mill as it stands has three trains, the roughing train through which the bloom makes five passes, the intermediate rolls, where five passes more are made, and the finishing rolls.

From the intermediate rolls the rails pass to the special cooling bed, where each rail is laid on its side with the head in contact with the flange of the rail in front of it. This contact somewhat equalizes the temperature, as much of the heat of the head of each rail is absorbed in the flange of the rail next before it. Thus the rails are not bent by the quicker cooling of the flange, as would be the case but for this contact. The rails are carried forward to the special cooling table by live rollers and transferred by dogs attached to ropes which are driven by a shaft worked by a hydraulic cylinder and ram. The final processes do not differ from those ordinarily in use except that the rails do not need so much curving in the cambering rolls because there is less difference of temperature in the head flange.

Observations on the finished product show much finer crystallization and more homogeneous structure in the steel finished at the lower temperature. It is found that the allowance for the contraction of the rail, to be made in setting the hot saws, will be reduced some 15 or 20 per cent. We are not told what the temperature of the rails passing the finishing rolls will be, but we are lately informed at the office of the R. W. Hunt & Co., that it will perhaps be about 1,400 degrees. That company is now experimenting with an optical apparatus for determining the temperature. It is believed that this can be worked out in such a way that it can be used by an inspector or operator in the mills. It seems to us that this is one of the most important improvements in rail making that has appeared in recent years, and we should expect great results from it. Obviously, if it is successful all of the rail makers will have to use it.

New Railroad Building in 1900.

Over 4,800 miles of new railroad was completed in the United States during the past year, according to the preliminary estimates of the *Railroad Gazette*. The returns cover 286 companies in 43 states and territories with 4,804.41 miles as the estimated total. These figures are necessarily preliminary, and the completed returns will undoubtedly add to this mileage. The comparison with the returns of 1899 is favorable, during which 284 companies built 4,569½ miles, the largest new building since 1891 and 1892. Only about 2,000 miles a year was built during the four years from 1894 to 1897.

Texas heads the states this year in new building with 313 miles. Five other states built more than 200 miles each; Iowa, 279 miles; Minnesota, 255; Pennsylvania, 235; West Virginia, 215, and Louisiana, 203 miles. Alabama built 187 miles; Mississippi, 173; California, 170; Georgia and Oklahoma, each 169; Florida, 157; Wyoming, 153, and South Carolina and Tennessee, each 146 miles.

Among the companies building the Chicago, Burlington & Quincy leads, with 213 miles in four states and territories. The Chicago, Milwaukee & St. Paul built 173 miles; the Chicago, Rock Island & Pacific, 169 miles; the Northern Pacific, 151 miles; the Chicago & Northwestern, 149 miles; the Burlington, Cedar Rapids & Northern, 100 miles; the St. Louis & San Francisco, 111 miles; the Seaboard Air Line, 95 miles; the Illinois Central, 91, and the Gulf & Ship Island, 70 miles. Most of the extended building was by the larger and older companies. In the accompanying table the mileage and number of companies building are given by states and

territories. For comparative purposes we print the similar figures of 1899.

New Railroad Building by States.

	—1899.—		—1900.—	
	Com- panies.	Mileage.	Com- panies.	Mileage.
Alabama	12	160.48	13	187.3
Alaska Territory	1	1.4	1	4.5
Arizona Territory	3	49.	4	48.
Arkansas	12	281.7	9	135.5
California	8	174.76	11	170.15
Colorado	5	83.42	7	139.6
Connecticut	3	19.65	10	157.5
Florida	10	138.7	10	169.04
Georgia	10	136.71	10	28.
Hawaii	—	—	3	50.41
Idaho	6	160.86	7	95.8
Illinois	5	96.7	4	66.7
Indiana	7	77.3	3	138.16
Indian Territory	5	77.	5	279.26
Iowa	10	563.97	—	—
Kansas	3	12.5	—	—
Kentucky	2	17.	4	29.9
Louisiana	6	137.22	13	202.93
Maine	4	41.	—	—
Maryland	4	41.	2	7.
Massachusetts	1	4.2	—	—
Michigan	13	168.86	9	126.35
Minnesota	9	374.35	8	254.79
Mississippi	6	141.68	6	172.92
Missouri	13	100.38	7	67.5
Montana	2	32.7	3	31.12
Nebraska	2	59.6	2	100.35
New Hampshire	—	—	1	18.54
New Jersey	1	9.5	2	4.44
New Mexico	3	125.39	—	—
New York	4	40.83	4	10.48
North Carolina	14	103.4	10	114.76
North Dakota	1	41.16	2	118.93
Ohio	6	77.82	6	27.1
Oklahoma Territory	4	157.21	5	169.4
Oregon	5	26.8	4	67.
Pennsylvania	34	212.23	31	234.85
South Carolina	5	123.72	6	145.76
South Dakota	—	—	3	101.6
Tennessee	5	54.46	11	145.59
Texas	8	91.59	18	313.43
Utah	4	93.95	2	8.95
Vermont	2	16.9	1	25.2
Virginia	4	63.75	6	70.
Washington	5	77.57	9	88.8
West Virginia	9	44.1	11	215.7
Wisconsin	9	47.27	8	110.3
Wyoming	2	9.27	4	152.81
United States	284	4,569.49	286	4,804.41

The Union Pacific has issued to its employees a circular notifying them that it will encourage accident insurance by paying a part of the cost for all employees who wish to take out policies in the Aetna Company of Hartford. The railroad company will bear one-third of the premium for all conductors, baggagemen, brakemen, locomotive engineers and firemen, yard foremen and switchmen, and bridge and building carpenters. For all other employees, it will bear one-fourth of the premium, the cost of insurance being lower in the less hazardous occupations. Instead of being obliged to pay the premium within four months, as heretofore, the employees will be allowed to pay their proportion of the premium monthly, the amount being deducted from their wages each month. For a practical means of showing the truth of the hackneyed phrase that the interests of capital and labor are identical, this appears to us to be one of the most commendable. It is not to be compared, of course, with more elaborate schemes, like those of the Pennsylvania and the Baltimore & Ohio; but, on the other hand, its simplicity is a strong point in its favor. The employee is entirely independent. It is as though the company merely secured for him a reduction in the insurance company's rates. The employee who is inclined to suspect that the road is trying to secure some underhanded advantage over him will find it difficult to discover in this arrangement any ground for his suspicion. The Chicago & Alton has had an arrangement of this kind for some time, paying, we believe, one-half the cost of all accident policies; and the officers of the road find marked satisfaction in the improved relations resulting.

The British Board of Trade return of train accidents for the first three months of 1900 shows eight passengers and six employees killed and 194 passengers and 62 employees injured. In 1899 there were no passengers killed in the first quarter. Nine of the reports of special investigations now published are signed by Lieut.-Col. von Donop, a new name. This return has a second appendix, filling 40 pages, giving condensed notes of reports made by Messrs. Ford and Hornby, sub-inspectors, on accidents to railroad employees and other persons employed on railroad premises. These reports deal chiefly with accidents in yards, freight houses, etc., in cases where there was no train accident. Each report, condensed, is divided into three paragraphs, shown in three parallel columns; (1), particulars of accidents; (2), conclusion as to the causes; (3), recommendations. In most of the cases the sub-inspector analyzes the causes and remedies with the same painstaking minuteness that we are familiar with in reports of the engineer officers on train accidents; but, in the nature of the case, some accidents almost defy analysis, and the recommendations which should be made are so obvious that there is no use in writing them out. Indeed, in some cases no recommendations are made. In numerous cases where the person injured was himself at fault, the conclusion is simply "that this accident was due to misadventure."

NEW PUBLICATIONS.

Hints on Painting Structural Steel. Revised edition. By Mr. Houston Lowe. The U. B. Publishing House, Dayton, Ohio. Price, 50 cents. This is a pamphlet in which Mr. Lowe, of the Lowe Bros., Dayton, Ohio, discussed the questions of paint and paint-

ing from a practical standpoint and in it there is embodied the general observations of a long experience with paints. The topics treated are paint, painting steel, rust, cleaning, the several liquids and solids used in paints and paint testing.

Compressed Air in New York.

We have kept the readers of the *Railroad Gazette* pretty well informed as to the development of the compressed air system in New York city, but are glad of the opportunity of publishing the extracts which appear below from a private report recently made to capitalists on this subject. The report is by a distinguished mechanical consulting engineer to whose opinion we attach much value.

"The mechanism is very skilfully worked out, and shows that its designers fully understand all the facts and conditions of the problem; there is no more danger of explosion than in the case of the ordinary steam locomotive. The car runs almost noiselessly, as regards the exhaust of the compressed air from the cylinders; during the period of starting and accelerating this exhaust is audible, but not offensively so; when the car is running at full speed the exhaust cannot ordinarily be heard except by a very attentive observer. The stopping of the car is quickly and surely effected by the brake mechanism.

"It is stated that one of these cars could run a distance of, say, 18 miles on a level or undulating track without exhausting its supply of compressed air; but, if the conditions were not favorable, and if many stops were to be made, the chances are that the maximum run before recharging could not exceed, say, 12 miles. In the Twenty-eighth and Twenty-ninth street cross-town service in New York, it is found necessary to recharge the cars after they have made two round trips, which corresponds to a total distance run of about 10 miles. On this particular run, however, there is an unusually large number of stops required. When these cars were first put into service at New York the consumption of free air was about 450 cu. ft. per car per mile. A systematic record of the performance of the individual cars and also of the individual motormen is being kept, and the management is confident that the consumption of free air can be reduced to 400 cu. ft. per car per mile.

"The actual advantages of this system of compressed air motors are, that the propelling apparatus is entirely self-contained, and requires no contact or connection with any external source of supply while the car is running, there being no trolley either overhead or underground, and when the car is once charged nothing more is required but a track for it to run on. The whole apparatus is clean, its operation is as noiseless as possible, and there is no visible exhaust of the propelling medium to frighten horses (as in the case of steam). The indications are that compressed air propulsion is as cheap as electric propulsion with overhead trolley, and cheaper than electric propulsion with the underground trolley or by storage battery.

"The application of compressed air for propulsive purposes has so far been limited to the four-wheel car, whereas there is an undoubted tendency in street railroad service towards the use of the eight-wheel car, both because with the eight-wheel car one crew can handle more passengers, and also because of the steadier riding qualities of the eight-wheel car, particularly at high speeds; the application of compressed air motors to an eight-wheel car, having two four-wheel trucks, necessitates a complete duplication of the motor mechanism now used on one truck, and would undoubtedly make the eight-wheel compressed air car more expensive, both in first cost and in maintenance, than the eight-wheel electric car. Besides this, the fact that an eight-wheel car must have swivel trucks, whereas a four-wheel car has its body mounted on its truck without a swivel feature, necessitates flexible power connections between body and trucks.

"In answer to the particular questions which you raise in your letter of Dec. 19, I am quite ready to say that, in my judgment, this Hardie mechanism as embodied in the compressed air street cars referred to, does make an entirely practicable and reliable form of motive power for suburban and street railroad business.

"There seems to be no reason why compressed air propulsion should not find a large field, more particularly in cities, in connection with automobile trucks for the transportation of freight and goods through the streets and on the ordinary pavements. Such trucks are always of the four-wheel type, and there are no problems of heating and lighting. Compressed air automobile trucks could be handled by unskilled labor, which would not be possible if either electricity or steam were the motive power."

Draft Gear.

Mr. R. P. C. Sanderson's written closure of the discussion of his draft gear paper at the Western Railway Club meeting, appears in the printed proceedings and brings out several points of interest. In the first place he gives the names of the makers of the riggings tested which forms the key to the table printed in our issue of Nov. 23. Referring to the riggings given there by letters: A is the standard single-spring draft gear of the Atchison,

Topeka & Santa Fe adopted to replace continuous draft gear previously in use; B, Miner standard tandem gear as usually furnished; C, the Santa Fe's modification of the same gear (Miner), having larger check plates and projections for the end sills; D, Miner draft gear of "Q" pattern, being somewhat heavier than B; E, Butler-Weiss tandem draft gear; F, Thornburg tandem gear; G, Dayton twin spring draft gear, with wooden beams (original design); H, Dayton twin spring gear, with recessed sill plates, and I, is the Dayton twin spring gear, with malleable iron beams.

Regarding the Westinghouse friction gear and the question of recoil it is said: "The Westinghouse draft-gear was tested, but as it appears to be beyond the capacity of the drop test to make any impression on it, at the request of the Westinghouse representatives the details of this test were omitted from the report, as they did not consider it a sufficient or fair test; they believing it to be in a superior class. With reference to the matter of recoil, we had no means of measuring the recoil of the weight with the different draft gears; but we did observe that with the double spring draft-gears the recoil was pretty much the same, depending on the strength of the spring and the resiliency of the spring, being about 3 in. at 10 ft. As to the effect of the recoil in breaking a train in two, this must be proportionate to the strength and the reaction of the springs."

Replying to some speakers who rather advocated the principle of the American continuous draft gear as the only correct one, Mr. Sanderson says that experience has shown that while this gear was an excellent one for short trains, it has proved a very expensive one to maintain for long trains and heavy tonnage. Further he says: "A draft gear must fulfil two requirements: First, it must pull the car itself with the least possible damage and strain; and, second, it must assist in pulling the train itself with the least possible damage and strain. The American continuous draft gear answers the first requirement better than any other, but there it stops. The design is such that the chain which goes to make up the train (say, of 50 cars) consisting of links formed by the couplers, draft keys, draft rods, etc., to the end of the train, is absolutely a wrought iron chain, without any spring protection, consequently the train shocks are not cushioned and the draft gear is torn to pieces, keys bent, rods stretched, etc., for lack of this spring cushioning action in the train itself."

The Wear of Rails in Tunnels.*

By THOMAS ANDREWS, F. R. S., M. Inst. C. E.

The ordinary wear of rails placed in tunnels is complicated by various factors, such as the increased corrosion of the surface of the rail, arising from the action of moist chemical vapors, and the increased chemical action of the ballast on the foot of the rail. The ballast in tunnels, owing to its general porous nature, absorbs the chemical vapors, and hence acts as an increased deteriorative force on steel rails.

The influence of tunnels on the wear of rails is varied and not always easily to be accounted for. The deterioration by the corrosive action of chemical vapors is sometimes greater in dry tunnels than in wet tunnels. This may possibly be accounted for by the suggestion that in wet tunnels the chemical vapors become absorbed in the water and more rapidly drain off, owing to the constant supply of drainage water, which tends to draw off the chemicals. In dry tunnels the chemical vapors are more likely to be absorbed and retained in a more concentrated form in the porous mass of the ballast, sleepers, etc. The deteriorative action due to corrosion in tunnels is of course increased by the local galvanic action (which is set up by the action of moist chemical vapors) between the steel rail and the metal chair, the latter acting as the negative element of a galvanic couple, and the steel answering to the positive element, owing to its being more easily attacked, chemically, than the cast metal. The effect of a tunnel will also be influenced by the relative direction of that tunnel as compared with the direction of the prevailing winds in the locality; and also by the contour of the surrounding country. Thus a tunnel in a low-lying valley, running through a high mountain, is not likely to have such ventilation as a tunnel situated in a higher and more exposed position. The effect of corrosive deterioration on rails, whether in the open air or in tunnels, is of course influenced by the situation of the line, such as contiguity to a sea atmosphere, or the passing of the line through districts in which there are large chemical manufactories, iron works, steel works, collieries, or other works which increase the atmospheric impurities.

Again, the effect of a tunnel on rails will depend considerably on its length, as in shorter tunnels there is greater opportunity for the chemical vapors to escape; and it will also be influenced by the nature and depth of the natural strata lying overhead. In all cases, however, it is essential that the permanent way should be carefully watched in tunnels, as the factors of deterioration are greater there than in other parts of the line. The nature of the strata forming the floor of tunnels also more or less influences the life of the rails.

It has been observed that the action of the acid vapors and products of combustion is chiefly noticeable on the bottom flange of the rail where its surface rests in the chair.

In order to investigate the effects of tunnels on the

*A paper read before the Institution of Civil Engineers.

wear of steel rails, the author made a careful examination of a rail which had done its life's work in such a situation. The portion examined was cut from the end of a Bessemer steel rail. The rail had been laid in a tunnel for seven years on a straight piece of road, having a falling gradient of 1 in 90, and it had carried the main line traffic for the above period without fracture. The tunnel is about 1,000 yards in length, and is situated fairly near the seacoast. A large traffic passes through the tunnel, which is constantly filled with a mixture of smoke and steam for at least 18 hours out of the 24. The length of the tunnel lies, in relation to the magnetic meridian, nearly due north and south.

This relation of direction to the magnetic meridian is mentioned because in a long research, the results of which were communicated to the Royal Society, the author observed indications that magnetization exerts an influence tending to increase the corrobisability of steel in certain solutions; and, as is well known, steel retains more or less permanent magnetism after having been magnetized. It may therefore be possible that steel rails gradually become magnetic from the influence of the earth's magnetism, when laid in a direction bearing a suitable relation to the direction of the magnetic meridian, and hence the corrosion in rails when so situated may be somewhat increased.

The rail had not been turned from end to end during its life, and the rolling stock had always passed over it in one direction.

General Examination.—The original section of the rail was 84 lbs. per yard. It weighed about 64½ lbs. per yard when taken out, which represents a loss, from wear and tear and corrosion, of about 2.8 lbs. per yard per annum. This is comparatively an excessive annual loss.

On the face the rail had worn down from the original section to the extent of ⅝ in.—a reduction which is also abnormal. The section of this rail when taken out was peculiar; the constant pressure and stress of wear had flattened or transversely rolled out the surface of the rail-face, so that it protruded on either side as a thin fin or web, varying in extent from about ¼ in. to ⅙ in.

The author made a careful examination of the wearing face of the portion of the rail received, which was found to be in tolerably good order, though in several places there were noticeable numerous shallow small blowholes and corrosion cavities, which had been rendered visible by the wearing action of the rolling stock. These cavities varied in length and width from about 5-16 in. downwards, and the depths of five typical ones were—0.055 in., 0.040 in., 0.060 in., 0.002 in., and 0.060 in. respectively.

The rail-face was, with one exception given below, free from either fine transverse or longitudinal cracks or flaws. The rail generally was not badly corroded, but the rail-bottom had suffered considerably from corrosion. The part where the rail had lain in the chair was worn down to the extent of about 3-32 in., and was in a rough condition. About 1 ft. from the end there was, on the outside of the bottom flange, a portion of the rail depressed to the extent of 1-16 in. On carefully examining the rail along the edge of the overlap or fin on either side of the rail face, there were found no transverse or other flaws or fissures, with the exception of one longitudinal fissure situated 1 ft. from the rail end and extending for a distance of about ½ in.

Chemical Examination.—Three separate careful analyses were made from drillings taken respectively from the head, the web, and the bottom of the rail, with the results shown in Table I.

Table I.—Chemical Analyses of the Steel Rail.

	Head.	Web.	Foot.
Combined carbon by color....	0.410	0.420	0.410
Silicon	0.063	0.057	0.062
Manganese	0.778	0.828	0.784
Sulphur	0.115	0.110	0.120
Phosphorus	0.051	0.048	0.048
Iron by difference.....	98.583	98.537	98.576

The combined carbon was satisfactory and as high as is desirable for rail-steel, and the silicon, manganese, and phosphorus were present in normal proportions. Sulphur, however, was present in great excess—nearly double the proportion that ought to obtain in a good steel rail. As the carbon and other elements were satisfactory, the excess of sulphur is to some extent responsible for the considerable wearing down noticeable in this rail. Further reference to this point will be made later in the paper. Except as regards the sulphur, the chemical analyses show good results, and the rail was free from any extensive segregation of the chemical elements beyond the micro-segregation of the sulphur compounds, referred to in the microscopic part of this investigation.

Physical Examination.—Portions were machined from the head and bottom and submitted to careful physical tests, with the results shown in Table II.

Table II.—Physical Tests, Steel Rail—2 in. Between Gage Points.

	Max. stress per sq. in.	Elongation, in. Per c't.	Reduction of area, Per c't.	Remarks.
Rail-head	37.86	27.5	44.0	Silky fibrous
Bottom	38.95	26.5	44.0	Silky fibrous

The results were satisfactory, the strength being normal and the elongation very good.

High Power Microscopical Examination at 300 Diameters.—A special section was cut from the rail-face and was carefully polished and etched with very dilute acid to develop the ultimate micro-crystalline structure. This was found to be generally somewhat uneven, so far as regards the distribution and disposition of the carbide-of-iron areas, as these were in places somewhat irregularly massed and variable in size and general structure.

In some places, however, there was a moderately good normal interlocking structure, as between the carbide-of-iron areas and the ferrite portions of the steel. The sectional area of the rail consisting of ferrite would be about 54 per cent., and the sectional area of the carbide of iron would be about 46 per cent.

Owing to the large excess of sulphur present in this rail, the micro-flaws (apparently chiefly due to sulphide of iron and sulphide of manganese) were found to be very numerous, and in many places they were massed in areas of micro-segregation. The individual sulphur micro-flaws were also mostly of considerable size.

Micrometer measurements were made of some typical internal micro-flaws, the dimensions of which are given in Table III.

Table III.—Dimensions of Typical Internal Micro-Flaws.

Longitudinal Dimensions.	Transverse Dimensions.	Longitudinal Dimensions.	Transverse Dimensions.
Inch.	Inch.	Inch.	Inch.
0.0024	0.0006	0.0018	0.0008
0.0012	0.0006	0.0016	0.0006
0.0012	0.0006	0.0016	0.0006
0.0024	0.0006	0.0020	0.0006
0.0020	0.0004	0.0024	0.0004
0.0006	0.0006	0.0020	0.0004
0.0008	0.0008	0.0032	0.0004
0.0034	0.0004	0.0030	0.0008
0.0014	0.0004	0.0032	0.0004
0.0030	0.0004	0.0036	0.0004

These are not the whole of the micro-flaws, but they are representative of those found in this rail.

General Conclusions.—A careful consideration of the results of the foregoing examinations, analyses, and tests, leads to the following conclusions:

1. The rail was worn down by the mechanical abrasion of its work to an abnormal and unusual extent, which indicates either that the rail had been subjected to an excessive amount of work within its limited time-life of seven years, or that it was deficient in physical endurance. In the latter case, the question arises, to what was this deficiency due?

The rail bore evidence on the wearing-face of having been subjected to very considerable grinding and abrasion, and the manner in which the steel had been bent or forced out transversely into extensive lateral fins showed that it had done a large amount of work.

Notwithstanding this, the wearing face was in fairly good order and normal general condition, though there were numerous effects of corrosive action and small blow-hole developments. At the point where the rail was laid there was a considerable amount of braking and skidding of wheels. An approximate estimate of the traffic which had passed over the rail was kindly furnished by the chief engineer of the line, from which it would appear that a total weight of about 48 million tons had passed over the line during the life of this rail, so that this single rail may be considered to have carried a total weight represented by 24 million tons.

The loss in the mass of the rail from corrosion on the web and bottom is very noticeable. The corrosion is often more excessive in tunnels than in the open air. The under surface of the rail-bottom, where it had rested in the chair, was much weakened by extensive transverse depressions and corrosion-cavities, though there were no actual fissures. These transverse depressions, or indentations, resulted from mechanical wear and the cold hammering which the rail had received in the chair, caused by the rolling stock passing over it. Another feature manifested in the bottom surface of this rail was the considerable extent to which the bottom of the rail, where it had rested in the chair, had been widened by mechanical shocks and the vertical pressure from passing trains.

2. The chemical analyses show that the general composition of the steel was excellent, the chemical elements being well balanced, with the exception of the sulphur, which latter constituent was present in considerable excess—nearly twice as much as ought to be present in a good rail-steel. The combined carbon was normal, and in a proportion calculated to promote both the durability and safety of the rail in service. The extensive wearing down of this rail is not, therefore, traceable to deficiency of carbon, but, in the author's opinion, it is due principally to the heavy amount of work put upon the rail, the normal wearing action being considerably intensified by the injurious physical effects arising from the micro-segregation of the sulphide of iron and the sulphide of manganese, to which allusion has been made in the account of the microscopical investigation.

3. The physical examination shows that the steel in the mass was of generally satisfactory quality.

4. The high-power microscopical examination, in conjunction with the chemical analyses, shows that the weak point in this rail was due to the excess of sulphur present.

This impurity, being present in such excess, had micro-segregated (as sulphide of iron and sulphide of manganese) as shown in a high-power micrograph. The presence of these innumerable minute areas of segregation had greatly facilitated (for mechanical-physical reasons easily understood) the disintegration and wearing down of the rail, under stress of wear, though the distribution of these sulphide micro-flaws throughout the mass of the steel was such as not to materially affect the physical strength of the rail as a mass, as shown by the tensile tests in Table II. Moreover, the normal crystallization of the carbide of iron and ferrite had also evidently been to some extent disturbed by the presence of the numerous micro-segregations of the sulphide of iron, allusion to which is made in the account of the microscopical examination of the rail.

The microscope detected and visibly demonstrated some

of the minute causes of internal weakness leading to the disintegration of this rail, confirmation being afforded by the result of the chemical analyses.

5. It is not generally desirable that rails should be allowed to wear down to the same extent as this one before being removed from the main-line service. On comparing the original section with the worn section it will be seen to how large an extent the strength of the rail had been reduced by mechanical wear, abrasion and corrosion; this being represented by a reduction in weight from 84 lbs. per yard to about 64½ lbs. per yard, which approximates to a total reduction in weight of 30 per cent., indicating a corresponding reduction in strength.

The author thinks it would be desirable also to have a heavier rail, weighing about 95 lbs. per yard, of a suitable section to meet the increased traffic and the weight of modern engines and rolling stock, and it is especially desirable to use heavier sections in tunnels.

6. In the author's opinion, judging from the results of numerous investigations of rails of known conditions of long service which he has recently made, a medium carbon and medium manganese rail, keeping the impurities, such as silicon, sulphur and phosphorus, within the lowest limits (as recommended in his recent chemical and physical specification for steel rails) will be found the safest and most durable for traffic of the kind which the rail referred to in this paper has been subjected. To insure that a reliable composition and structure of rail is obtained, it is of advantage for railway companies to have their new finished rails (apart from the maker's test of the ingot) chemically and physically tested.

It has been seen that the corrosion of the steel rail in the tunnel has been at the average rate of 2.8 lbs. per yard per annum, which is largely in excess of the normal wear outside tunnels. Elsewhere it has been observed that the flange of a Vignoles rails corroded in various places to the extent of 0.086 in. within 2½ years, and in other situations rails have been known to corrode as much as 0.260 in. within 3½ years.

A corrosion as high as 0.390 in. has been observed on the underside of a rail-flange, with a maximum wear in the head of 0.490 in., within a period of 11½ years. This excessive wear in tunnels may be obviated by employing heavier general sections with a wider wearing-face, and by special selection of rails of a chemical composition and physical structure best adapted for wear in such a situation. Longitudinal sleepers and heavy-sectioned flat-bottom rails may be used with advantage. With transverse sleepers it is desirable to increase the number of sleepers per yard.

In Table IV the author gives for purposes of comparison the approximate loss in weight, in pounds per yard per annum, of a number of rails he has examined, which have endured the heavy wear of main-line traffic in the open air to a similar extent to that of the rail referred

Table IV.—Average Loss in Weight per Annum of Eleven Rails of Known Age and Conditions of Main-Line Service.

Time-life.	Ave. loss in weight per annum.
22 years.....	0.260 lbs. per yard
24 ".....	0.310 " "
23 ".....	0.130 " "
23 ".....	0.130 " "
21 ".....	0.480 " "
25 ".....	0.420 " "
17 ".....	0.320 " "
18 ".....	0.280 " "
18 ".....	0.280 " "
19 ".....	0.630 " "
Average 21 ".....	0.324 " "
7 ".....	2.800 " "

to above. From this it will be seen that the effect of the tunnel has been to increase the wear of the rail from an average of say 0.324 lb. per yard per annum to the high average of 2.8 lbs. per yard per annum. The rails were selected at various places over a length of about 200 miles of main line.

The author considers as a general rule that rails in tunnels should only be allowed to remain in the permanent way for one-half (or in some cases only one-third) the time that is usually allowed for their ordinary use outside tunnels; thus if 14 years may be regarded as the life of a rail under ordinary circumstances, seven years may be regarded as the maximum life allowed in average tunnels, consistent with safety. This conclusion is of course open to exceptions, according to varied circumstances. In special instances rails in tunnels ought to be taken out after a less period of wear than suggested above, and there are tunnels in which rails ought not to be retained in the permanent way for a longer period than three or four years.

These matters, however, will vary according to the nature of the tunnel and the extent and character of the traffic imposed on the rail, so that it is not easy to make a general rule.

The Economy of Compounding.

At the October meeting of the New York Railroad Club a short incidental discussion came up on the economy of compounding locomotives. A report of it follows:

Mr. Forney—I would like to ask Mr. Pomeroy, who is present this evening—and who is identified with a locomotive building establishment and it may be presumed has

seen the accounts of the superior economy of the Northwestern engine—whether it is probable that the economy of that locomotive could be increased anywhere from 10, 15 to 20 per cent. by compounding? Is it probable that as much economy could be effected, or as large a percentage of economy could be effected on that engine by compounding, as is claimed for that system on other engines?

Mr. Pomeroy—I should certainly say yes. The economy spoken of there of 20 per cent. was due to the slower rate of combustion. Some of those engines against which this engine was working were burning in doing the same work 200 lbs. of coal per sq. ft. of grate per hour, and a grate surface of about 33 sq. ft. In the Northwestern type the grate surface is 46 sq. ft.; so that you see the rate of combustion is very much reduced, which made better evaporation, directly in the line of Prof. Goss' experiments at Purdue in that respect, which showed about 30 per cent. more water evaporated per pound of coal when the rate of combustion was 150 lbs. per sq. ft. of grate per hour than when the rate was 200 lbs. per sq. ft. of grate per hour. To that I attribute the economy of the feature spoken of there, and in freight service the economy from compounds has been all the way from 18 to 20 per cent., and it has been an open question in my mind on a road of that kind, in fast passenger service, whether there would be as much economy reached by the compound as there would be in the freight service.

Mr. Forney—Mr. Chairman, I understand Mr. Pomeroy to say that the economy in the Northwestern type of engine was due to the economy in the boiler?

Mr. Pomeroy—The boiler and the fire-box.

Mr. Forney—The economy claimed for compounding is in the use of the steam. If that is the case, if we improve the boiler and fire-box of the engine, as they did on the Northwestern engine, and then compound it, we could get an economy of 40 per cent., assuming that the compound gives an economy of 20 per cent.

Mr. Pomeroy—Assuming that, yes, sir.

Mr. Forney—I see Mr. Pomeroy is very conservative. Mr. West—I cannot agree with Mr. Pomeroy on that. I think the "Why not" is that the other fellow always wants to tackle the problem at the 100 mark, and not at the 80 or before someone has already sliced off 20 per cent.

Mr. Forney—I am disposed to follow this up a little closer. If the compounding will save as large a percentage as is represented in the statements that are put before the public, I do not see why they should not save as much on the Northwestern type of engine as they do on any other types. The economy in compounding, as I understand, arises from the more economical use of the steam. Now, if you can have a more economical use of the steam and thus effect an economy varying from 10 to 20 per cent. on a certain class of engine, why cannot you do it in another class?

Mr. Gaines—I do not think that all the economy in compounding is gained in the steam distribution. I think a part of the benefit comes in from the fact which Mr. Pomeroy mentioned, that engines that are cramped for grate area and have a very high combustion rate are relieved to some extent. You are getting better steam distribution and you are also getting some of the gain in the decreased rate of combustion of the fire-box.

Mr. Forney—If the compound engines weigh from 10,000 to 7,000 lbs. more than simple engines do—

Mr. Pomeroy—They do not weigh that much more.

Mr. Forney—It depends on the type of compound engine, I think, somewhat. If you take that extra weight and put it into the boiler, increase the size of the simple boiler, you ought to get as good results in the increased boiler of the simple engine as you do with the boiler of the compound engine. So that I think in that case you would realize the boiler economy in the simple engine, and in that way I do not think you get so high an economy as claimed for the compound engine under a fair test.

TECHNICAL.

Manufacturing and Business.

The cars being built by the American Car & Foundry Co. for the United Fruit Co. will be fitted with American car couplers ordered through T. N. Motley Co.

During the last 15 days of December the American Dust Guard Co. shipped dust guards as follows: To the Pressed Steel Car Co., 16,000 for 5½ in. x 10 in. journals; to the American Car & Foundry Co., 3,200; to the Hocking Valley, 1,000; to the Baltimore & Ohio Southwestern, 500; to the Barney & Smith Car Co., 3,200.

The H. W. Johns Manufacturing Co. is at work on the twenty story Broad-Exchange building, corner of Broad street and Exchange place, New York, applying its asbestos covering. The riser pipes alone require over 40,000 ft. of covering, and when the pipes are all covered there will be put on between 50,000 and 60,000 cu. ft.

The B. F. Sturtevant Co., of Boston, Mass., reports its business of the past year to have been the largest in its history. In the line of standard types of blowers, exhausters and hot blast heating apparatus, its products have kept pace with the recent industrial movement, and in the installation of fans for the production of mechanical draft for steam boilers there has been a great increase. The volume of domestic and foreign orders

for forges has been noticeable while the output of the rapidly growing electrical department has been far in excess of the previous year. This electrical output has been principally in specialties, namely, electric fans of all types and small high-grade generating sets.

Mr. Ira C. Hubbell has been elected Vice-President of the Natural Food Company, a company of \$10,000,000 capital, incorporated under the laws of the State of New York which is building a plant at Niagara Falls. The main building is 540 ft. long and 66 ft. wide. The plant will be operated exclusively by electricity, the present installation calling for 5,000 electrical horsepower. The Natural Food Company has absorbed the business of the Shredded Wheat Company, and will materially increase the product of foods made from cereals and in which the entire cereal is used, nothing taken from or added to the grains. Mr. H. D. Perky, formerly President of the Shredded Wheat Company, is President and managing officer of the new company. Mr. Hubbell will retain the presidency of the Locomotive Appliance Company and give only incidental attention to the affairs of the food company.

Iron and Steel.

George F. Baer, a director of the Philadelphia & Reading, will, on Jan. 1, become President of the Temple Iron Company, to succeed Thomas H. Watkins, resigned.

A Glasgow despatch of the 20th, says that the Clyde shipbuilders recently placed orders for 150,000 tons of plates in the United States, at a saving of £50,000.

A London despatch says that McEwan & Co., who secured a contract to furnish 2,000 tons of rails and fish-plates for the Victorian State Railroads, have placed the order with the Illinois Steel Co., of Chicago.

The Philadelphia & Reading has contracted with the Neafie & Levy Ship & Engine Building Co., for one steel seagoing tug, 170 ft. long, 29 ft. beam and 15 ft. draught, and with Robert Palmer & Son, Noank, Conn., for 10 seagoing barges. The contracts aggregate over \$300,000.

The Lucknow Iron & Steel Co. will be chartered, in Pennsylvania, in January, to operate the Lucknow Forge and the Pine Works at Pottstown, Pa. The incorporators will be James B. Bailey, President; Leroy J. Wolf, Charles L. Bailey, Jr., H. L. Champlain and John W. Reily.

At the No. 2 rod mill of the Illinois Steel Co., at Joliet, in the night turn of Dec. 10, the record was exceeded in an output of 537,700 pounds, or 240 gross tons, of No. 5 rods. The greatest reported record previous to this was made at the Rankin plant of the American Steel & Wire Co., the day turn of Nov. 8 producing 515,030 lbs. of No. 5 wire rods.

According to a Berlin despatch prices for rolled wire have been reduced from 185 to 150 marks per ton. An auction sale of sheet iron at Dortmund brought from 110 to 115 marks per ton, as against 140 marks, the prevailing price. The pig iron production from Jan. 1 to Nov. 30 was 7,630,953 tons, as compared with 7,384,231 tons for the corresponding period of last year.

The American Bridge Co. has lately taken a contract for three large viaducts on the Chicago, Burlington & Quincy, and also a 300-ft. draw span for the same company. The Chicago, Rock Island & Pacific has ordered from this concern 3,500 tons of material to be delivered during 1901. Among other large contracts of the American Bridge Co. is the highway bridge at 145th street, New York (see *Railroad Gazette*, Dec. 14, p. 833), two large viaducts for the Oregon Short Line; 25 highway bridges in Kansas, the structural steel work for the new 14-in. continuous mill for the Carnegie Steel Company at the Duquesne Steel Works; the structural steel work for a new armory at Medina, N. Y., and the steel for the blacksmith shop for the Atchison road at Topeka.

Draft Gear Tests.

We are glad to learn (although the information is unofficial) that the Executive Committee of the Master Car Builders' Association has appropriated \$1,500 for tests of draft gears, and we learn also that Mr. R. H. Soule has been selected as the expert in charge of the tests. Nothing could be more satisfactory than this, we are sure, to the makers of draft gears as well as to the railroad companies. Everybody will accept the work and opinion of the expert. The Committee on Draft Gear consists of E. D. Bronner (Chairman), G. F. Wilson, Mord Roberts, T. A. Lawes and C. M. Mendenhall. We have not learned any particulars as to when and where the tests will be made and assume, in fact, that no arrangements for these tests are yet started.

A New Ticket Dater.

The Michigan Central will at once supply 100 of its principal coupon stations with a new form of ticket dater, which it is believed will be found an improvement over the present stamps. The new dater was devised by Mr. A. J. Burt, Auditor of the Michigan Central, and Mr. W. F. Parsons, formerly Ticket Accountant of the same road. The name of the road, station and date of sale are embossed in high relief; the punch limit and written or stamped destination are protected by a milled strip at the sides of the ticket and along its entire length. The embossing and milling are done by passing the ticket once through suitable rolls. These rolls are so arranged that the dates are easily changed. The daters are adapted for use with both coupon and local tickets. It is said that several roads other than the Michigan Central will make trials of these daters.

¹This rail had been laid in a tunnel during the whole of its life. The other ten rails had been in the open track.

THE SCRAP HEAP.

Notes.

It is said that the number of employees on the Pennsylvania Lines West of Pittsburgh who will be retired on pensions at the beginning of 1901 is 250.

Smoking cars, which have been run on the elevated railroads of Brooklyn for a number of years on all, or nearly all, of the trains, have been all taken off.

Traffic Notes.

The *Journal of Commerce* says that the Trunk Lines will appoint a joint agent at New York to supervise west-bound shipments of import traffic.

Pittsburgh papers report that the Carnegie Steel Company is loading 100 barges with rails (50,000 tons) to go down the Ohio River. The rails go to various points along the Mississippi River as far south as New Orleans.

Reports from Chicago state that the roads east of that city have been making reduced rates in contracts for freight to be sent East after Jan. 1. It is said that flour for export is carried at two cents under the tariff, and provisions 7½ cents. But on grain it is said that the shippers have been unable to secure reductions.

Chicago papers say that the roads west of that city have established a permanent committee on car mileage, with a view to preventing the payment of excessive rates for cars hired from private owners. A resolution has been adopted not to pay over six mills a mile for common cars, and 7½ mills for refrigerator and tank cars.

The Railroad Commissioners of Minnesota have issued an order to the Duluth, Missabe & Northern and the Duluth & Iron Range directing those companies to reduce their rates on iron ore. Rates which are now 60, 80 and 100 cents a ton are reduced 20 cents. It is said that this reduction, if carried out, will reduce the earnings of the roads a million dollars a year.

Chicago papers report that the scalpers of that city are doing a considerable business with altered tickets. Tickets are bought from New York to a short distance beyond Chicago and the coupons west of Chicago are "raised." It is said that Thrall's simplex tickets have been altered, as to destination, number and time limit; and that some of the alterations are as clever as ever was done in forging checks.

Regulating the Weight of Street Cars.

A bill was introduced in the House of Representatives last week prohibiting the use of electric street cars weighing more than 9 tons on the Metropolitan road within the city of Washington. The bill provides that all cars shall be of the size, weight, style and equipment of the "green" cars used on the line, and is aimed at the new long cars on that road, previously referred to in this column. A maximum speed of 12 miles an hour is also provided for, and no car with a broken flange or flattened wheel shall be operated. Penalty for violation of the act is fixed at \$100 a day for each car.

The Traffic at the Soo.

The officer in charge of the St. Mary's Falls Canal (Sault Ste. Marie) has published a comparative statement of lake commerce at the Soo for the seasons of 1899 and 1900. The number of vessel passages decreased 4 per cent., having reached in 1900 a total of 19,452. The registered tonnage and the freight tonnage increased, each 2 per cent., the total freight having been 25,643,000 net tons. The number of passengers increased 19 per cent., reaching the total of 58,555. There was a decrease of 31 per cent. in the wheat carried and 46 per cent. in grain other than wheat. The soft coal increased 28 per cent., and the iron ore 7 per cent. The totals were: Wheat, bushels, 40,489,000; other grain, bushels, 16,175,000; soft coal, net tons, 3,971,000; iron ore, net tons, 16,445,000; flour, barrels, 6,761,000; general merchandise, net tons, 541,000.

Proposed Mississippi River Bridges.

The Committee on Commerce of the House of Representatives, on Dec. 18, took up for further consideration the bills for the proposed railroad bridges over the Mississippi River at points about 35 miles apart, namely, Cape Girardeau, Mo., and Gray's Point, near Cairo, Ill. The matter was again to be considered on Thursday of this week. The Southern Missouri & Arkansas Railroad is interested in the Cape Girardeau project, and the Illinois Central, Missouri Pacific and the St. Louis Southwestern are interested in the Gray's Point bridge.

Grade Crossings and Terminals in Washington.

The House of Representatives on Wednesday of last week passed the bills requiring the Pennsylvania and the Baltimore & Ohio railroads to abolish grade crossing, to alter their routes into the city and to improve their terminals. An amendment was made to the Pennsylvania bill to require the road to build a new station to cost not less than \$1,500,000. The bills were vigorously antagonized by a portion of the minority upon the ground that they were too liberal to the roads.

The House District Committee, on Dec. 13, took up for consideration the Senate bill to abolish grade crossings on the Baltimore & Ohio Railroad, in Washington, D. C., and permitting that railroad to build, outside of the city limits, and south of T street, yards, tracks, switches, roundhouses, shops and other structures necessary for a freight yard. Also to locate, beyond the city limits, a branch track or Y for the passage of trains directly to and from between the Metropolitan branch and the Washington branch without entering this city.

Large Rolled Steel Output.

The output of rolled steel of all kinds for the year will be about 1,000,000 tons greater than last year, when the total rolled tonnage was 10,357,397. The output as figured by Pittsburgh experts is considerably over 11,000,000 tons. It has been the impression that the steel output would be less than in 1899. During the early part of 1899 the mills were not as generally engaged as they were towards the latter part of the year. The capacity has been increased materially by additional plants, especially in plates. The bulk of the rail tonnage ordered last year was finished this year.—*Pittsburgh Commercial Gazette*.

Exports of Rails and Locomotives.

According to the Bureau of Statistics our exports of rails in the year 1900 will aggregate \$12,000,000, or an average of \$1,000,000 per month, while it was not until 1897 that the figures for any entire year reached as much as \$1,000,000. In the fiscal year 1890 the total value of rails exported was \$315,000; in 1896, \$540,000; in 1897, \$2,500,000; in 1898, \$4,500,000; in the fiscal year 1899, \$5,250,000, and in the calendar year 1900 it will be fully \$12,000,000. Nearly \$1,000,000 worth of these go to Europe; another million to Mexico; nearly two millions to South America; four millions to British North America, and two millions dollars' worth to Asia and Oceania.

American locomotives also go along with the American steel rails, and the total for the year seems likely to reach about \$5,000,000 in value. American rails and locomotives are in turn accompanied by American cars, of which the exportation for steam railroads will amount to \$3,000,000 during the year and for other railroads to more than a million dollars. Add to this a proper share of the \$6,000,000 worth of electrical machinery and \$6,000,000 worth of telegraph, telephone and other electrical instruments and scientific apparatus exported, and it will be seen that for the construction and operation of railroads outside of the United States the manufacturers of this country will supply during the year about to end fully \$25,000,000 worth of material.

Pensions on the Chicago & Northwestern.

A press despatch of Dec. 21 says that the directors of the Chicago & Northwestern have decided upon a permanent pension system for the 27,000 employees of the road, to go into effect on Jan. 1, 1901. The pension system is patterned in many respects after that of the Pennsylvania. How many employees of the road the system will immediately retire the officials have not yet ascertained, but it is estimated that eventually the plan will call for an annual expenditure of \$200,000.

British Locomotive Orders.

The Midland Co. have recently ordered 130 engines, and the order has been divided as follows: 60 goods engines and tenders, Messrs. Neilson, Reid & Co., Glasgow; 20 goods engines and tenders, Messrs. Sharp, Stewart & Co., Glasgow; 20 goods engines and tenders, Messrs. Kitson & Co., Leeds; 30 large goods tank engines, Vulcan Foundry Co. (Limited), Newtown-le-Willows. Messrs. Hudswell, Clarke & Co., Ltd., have secured, in competition with American builders, an order for six engines for the Port Talbot, and six for the Taff Vale, and have just delivered nine to the Rhymney.—*Railway Engineer*.

Some Official Changes on the Pennsylvania Lines.

The working of the new pension retirement system on the Pennsylvania lines will bring about a number of changes, and still other changes will be caused by the promotion of Mr. L. F. Loree to be Fourth Vice-President. We have no official information with regard to any of these changes, but we think it is safe to say that Mr. Loree is to be Fourth Vice-President and that Mr. Potter will succeed him as General Manager. Mr. J. F. Miller will retire as General Superintendent and Mr. F. Watts will retire because of ill health. Press despatches say that Mr. Miller and Mr. Watts will be retained in the service as advisory officers. We hear nothing that it is safe to repeat concerning the successors of any of these officers.

No More Trainboys on the Erie.

After midnight of Dec. 31, newsboys will not be permitted on any trains of the Erie System west of Salamanca, and after Jan. 31 the same condition will exist on trains east of Buffalo and Salamanca. After the last-named date, newsboys will not be permitted on any trains on any portion of the Erie Railroad System.

LOCOMOTIVE BUILDING.

The Erie is having three engines built by the Baldwin Locomotive Works.

The Central of Peru is contemplating ordering two or three locomotives.

The Pere Marquette is having five engines built by the Brooks Locomotive Works.

The Philadelphia & Reading has ordered 45 engines from the Baldwin Locomotive Works.

The Detroit & Mackinac will be in the market for a few locomotives after the first of the year.

The Illinois Central has ordered 39 locomotives from the Pittsburgh Locomotive & Car Works.

The New York, Ontario & Western is having one locomotive built by the Dickson Locomotive Works.

The Pittsburgh, Bessemer & Lake Erie is having five locomotives built by the Pittsburgh Locomotive Works.

The Delaware, Lackawanna & Western has ordered 20 more consolidation engines from the Schenectady Locomotive Works.

The Chicago, Rock Island & Pacific has ordered 23 locomotives from the Brooks Locomotive Works, and will probably place further orders.

The Chicago Terminal Transfer order with the Baldwin Locomotive Works, mentioned in our issue of Dec. 20, calls for six consolidation engines for June delivery. They will weigh 188,000 lbs., will have 22 in. x 28 in. cylinders, 51-in. driving wheels, 74-in. straight top boilers, 220 lbs. pressure, fire-boxes 122 in. long and 73 in. wide, tender capacity 6,000 gals. of water and 10 tons of coal. The specifications include Westinghouse brakes, Ohio and Sellers' injectors, Nathan lubricators, Damascus nickel bronze bearings, A. French springs, Cole safety valves, Ashcroft gages, Star headlights and Gollmar bell ringers.

CAR BUILDING.

The Brooklyn Rapid Transit Co. will order 50 motor cars for its elevated division.

The Missouri Pacific has ordered 2,500 cars from the American Car & Foundry Co.

Nelson Morris & Co. have ordered 100 cars from the Illinois Car & Equipment Co.

The Detroit & Mackinac will be in the market for about 150 gondolas after the first of the year.

The St. Louis Southwestern has ordered 500 freight cars from the American Car & Foundry Co.

The Los Angeles Terminal has ordered five passenger coaches from the American Car & Foundry Co.

The San Antonio & Aransas Pass has ordered 200 freight cars from the American Car & Foundry Co.

The Chicago, Indianapolis & Louisville has ordered 200 flat and 50 stock cars from the Haskell & Barker Car Co.

The New York, Ontario & Western will be in the market, after Jan. 1, for six passenger and two parlor cars.

The St. Louis & San Francisco has ordered from the American Car & Foundry Co. 10 coaches and five baggage cars.

The Ohio River has placed an order with the American Car & Foundry Co. for 250 gondola cars and 14 passenger cars.

The St. Charles Refrigerator Despatch has ordered 50 refrigerator cars from the American Car & Foundry Co.

The Costa Rica Government Railroads have ordered from the Hamlin Car Co., through the Thornton N. Motley Co., 30 flat cars.

The American Car & Foundry Co. has received miscellaneous orders amounting to 150 small coal cars, 25 box cars and 20 logging cars.

The Cleveland, Lorain & Wheeling has ordered 500 gondola cars of 80,000 lbs. capacity, 150 box cars of 60,000 lbs. capacity, and 50 stock cars from the Pullman Co., all for April delivery.

The Wabash has placed an order with the American Car & Foundry Co. for 25 passenger and eight combination coaches and two baggage cars, and has also ordered from the Pullman Co. 10 chair cars, five coaches and three dining cars.

The Philadelphia & Reading has ordered 1,000 steel coal cars of 100,000 lbs. capacity from the Pressed Steel Car Co.; 600 steel cars from the Cambria Steel Co.; and 500 box cars, with steel underframes, from the American Car & Foundry Co.

BRIDGE BUILDING.

AKRON, OHIO.—City Engineer J. W. Payne has been instructed by the Board of City Commissioners to prepare plans and specifications and an estimate for a bridge on Cuyahoga street, across the Little Cuyahoga River.

BATTLE CREEK, MICH.—The City Charter will be amended to permit the city to be bonded for \$50,000, \$25,000 of which is for bridges.

BINGHAMTON, N. Y.—The bridge over Ross Park Creek at Cross street has been closed as being unsafe for traffic.

BOSTON, MASS.—City Engineer William Jackson, according to reports, will soon advertise for bids for the retaining wall for the approach to the bridge proposed over Fort Point Channel and the tracks of the Terminal Company between Atlantic avenue and South Boston, known as the Cove street bridge. The War Department has approved the report of the Government Engineer in favor of this bridge. Plans are being made.

Plans for a temporary bridge at the site of the old Broadway bridge, to South Boston, have been made. The old bridge will be replaced by a new steel structure when the appropriation is made.

BUFFALO, N. Y.—The Legislature is to be asked to appropriate \$25,000 for a steel drawbridge over the Ferry street crossing of Black Rock Harbor. The present wooden bridge is dilapidated. Two years ago the state appropriated \$18,000 for a bridge there, but \$7,000 more is needed. Plans for the new bridge have been prepared by State Engineer Edward A. Bond.

CATSKILL, N. Y.—The New York Central & Hudson River R. R. expects to rebuild the West Shore bridge at Catskill, but not at once.

CHIPPewa FALLS, WIS.—Bids will be wanted at an early date for the bridge to be built over Chippewa River. It will be of five spans, each 165 ft. long with 24 ft. roadway. It must be built this winter. William Bowe, Chairman Committee. O. J. Nylhus, City Engineer. (Dec. 21, p. 850.)

CINCINNATI, OHIO.—New bids are wanted, on Jan. 16, for rebuilding the superstructure and approaches of the Liberty street viaduct. Robert Allison, President Board of Public Safety. (Oct. 26, p. 710.)

CLEVELAND, OHIO.—The following bids were reported received by the Department of Public Works, Dec. 12, for the superstructure of the bridge over Cuyahoga River at Middle Seneca street: King Bridge Co., Cleveland, \$63,930; C. L. Strobel, Chicago, Ill., \$56,195; Toledo Bridge Co., Toledo, \$66,190; J. H. Webster, assignee of the Variety Iron Works Co., Cleveland, \$67,632.

DES MOINES, IOWA.—A large viaduct, 200 or 300 yards long, will be built over the railroad tracks on West Fifth, Seventh or Ninth street next spring. The locating of the Army Post site south of the city necessitates the viaduct.

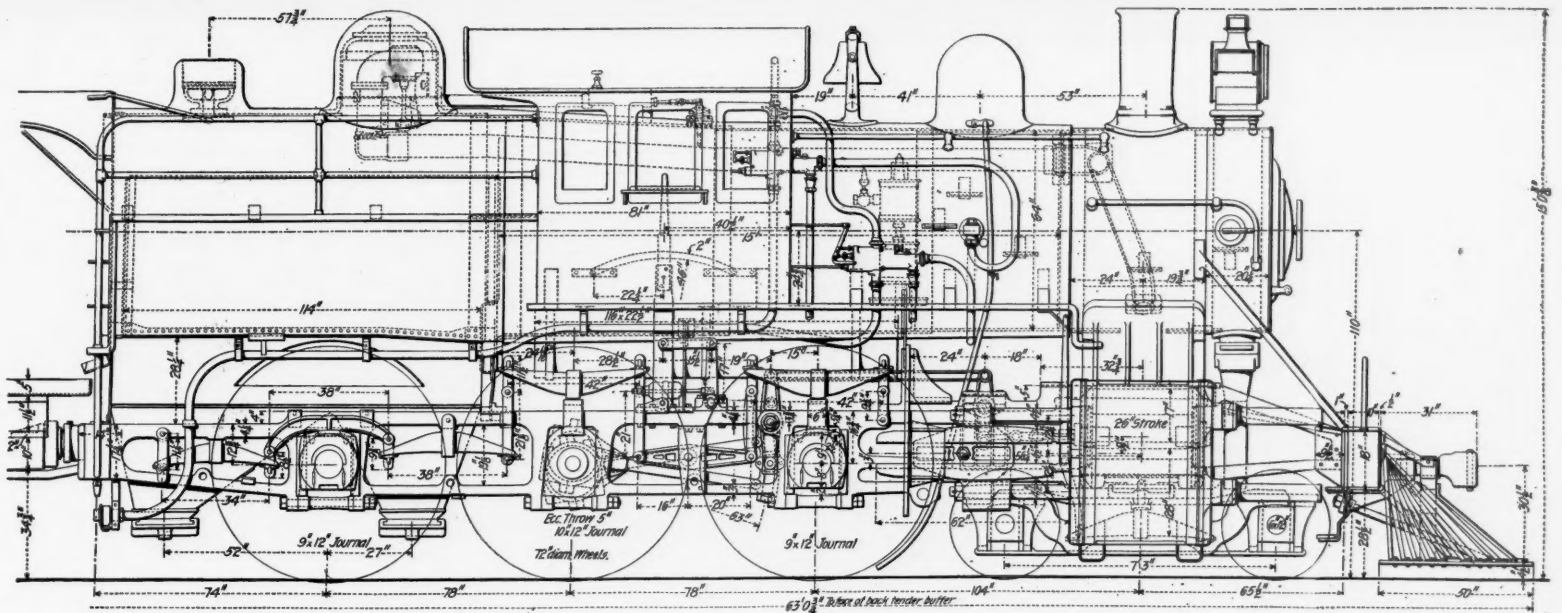
DILLON, MONT.—The County Commissioners, at the March meeting, will consider bids for a 100-ft. bridge over Big Hole River.

DUBUQUE, IOWA.—Surveys, according to report, have been made by the City Engineer for a viaduct at Fourth street.

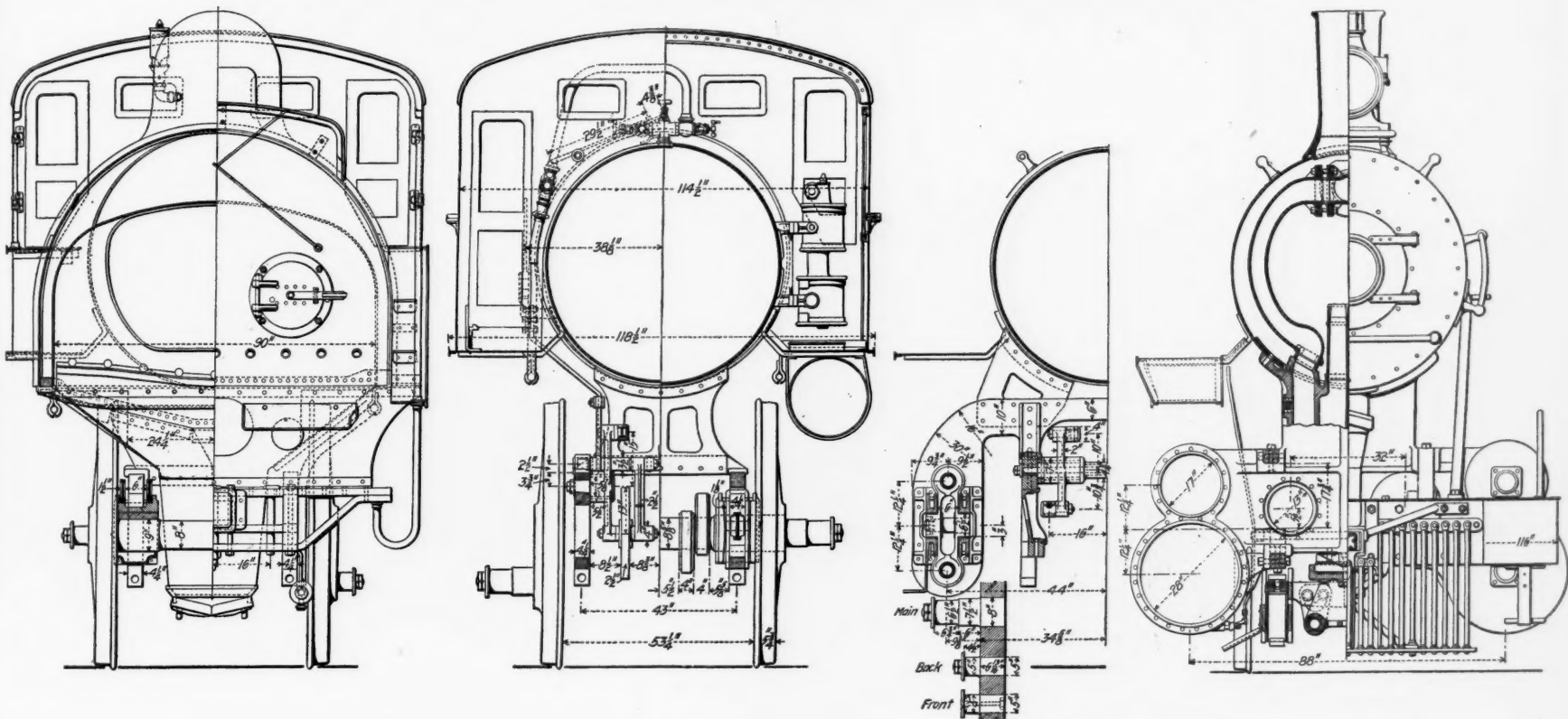
GENEVA, N. Y.—We are officially informed that, on the Pennsylvania Division, the New York Central & Hudson River R. R. intends to rebuild, with steel, all the existing light bridges on the Fall Brook District from Geneva, N. Y., to Newberry Junction, Pa., a distance of about 160 miles, and also intends to renew light structures on the Beach Creek District from Jersey Shore, Pa., to Youngdale, and from Clearfield to Mahaffey, Pa. The contracts for the larger portion of this work have not yet been let.

HARRISBURG, PA.—We are informed that plans and specifications are being made for the subway under the Pennsylvania and the Philadelphia & Reading railroads, and the lift bridge over the Pennsylvania Canal on Market street. The cost, which is estimated at \$80,000, will be paid by the railroads and the city. M. B. Cowden, City Engineer.

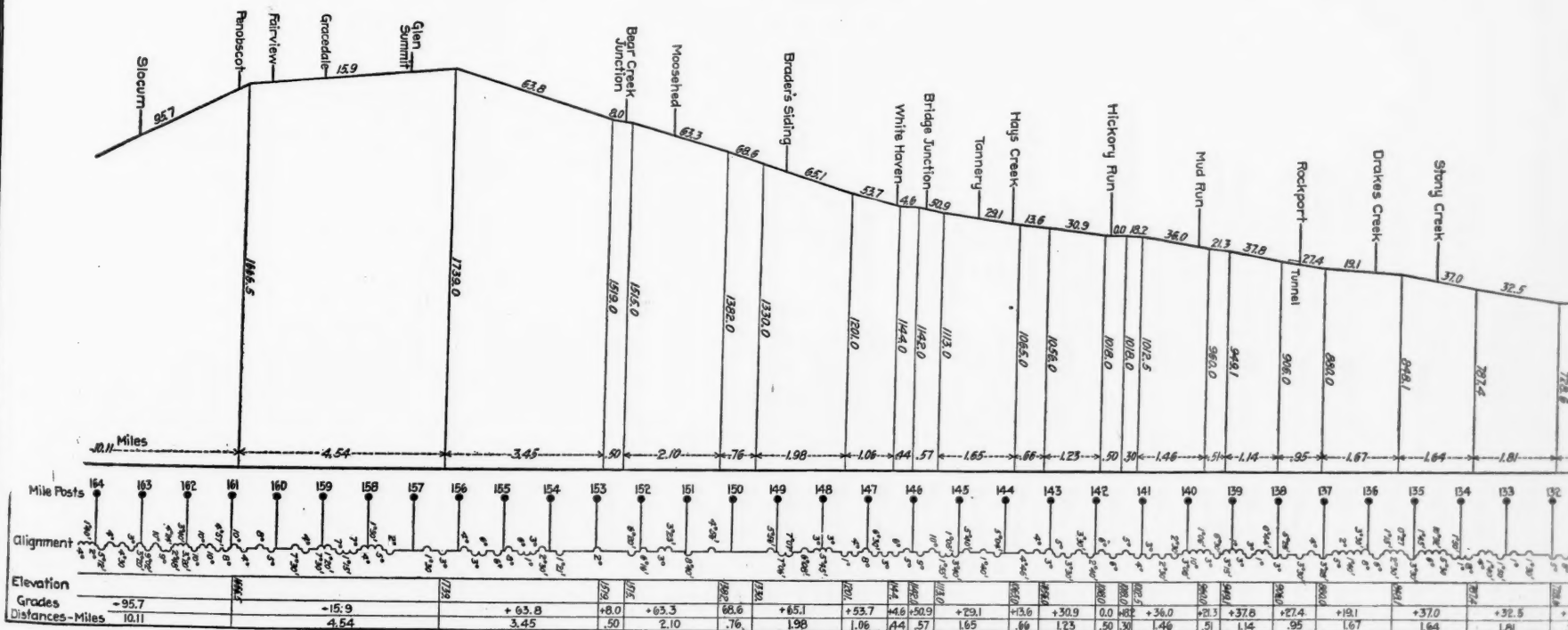
NEW BEDFORD, MASS.—Separate proposals are wanted, on Jan. 23, for the foundations and the steel work on the



General Elevation of Engine.



Elevations and Sections.



Profile of Lehigh Valley Railroad—Mauch Chunk to Slocum, Pa.

Mr. F. F. GAINES, Mechanical Engineer.

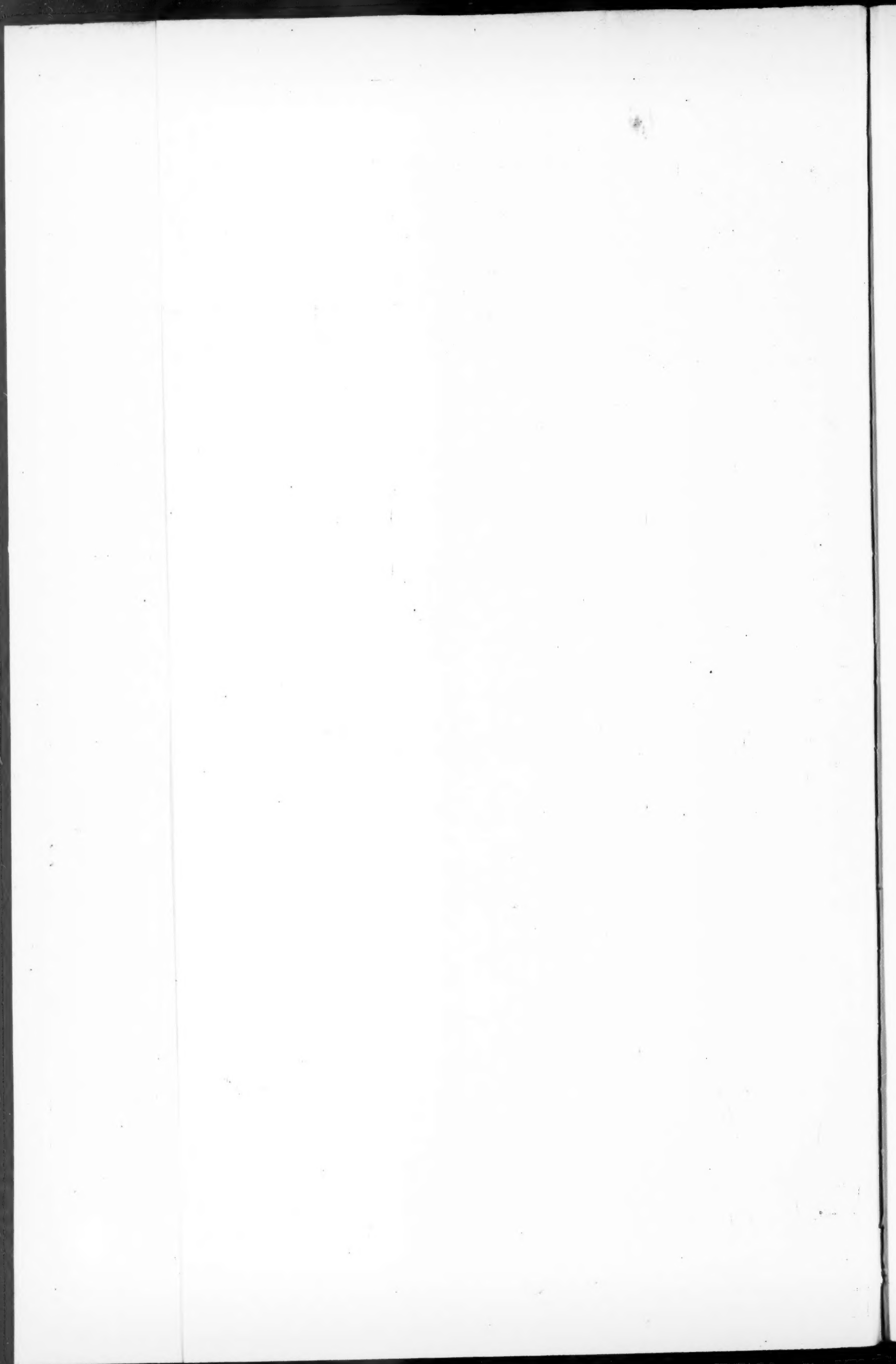
VAUCLAIN TEN-WHEEL COMPOUND PASSENGER LOCOMOTIVE, CYLINDER

[illegible][illegible][illegible][illegible][illegible][illegible]

MR. S. HIGGINS, *Superintendent Motive Power.*

The diagram is a geological cross-section of a road cut. The road profile is shown at the top, with stations 133 to 123. The road surface is marked with station numbers and elevations. The road cut shows different geological layers, with some layers labeled with names like 'Glen Onoko' and 'Mouth Chunk'. The diagram includes a scale bar at the bottom with values from +32.5 to -1.81. The road cut is shown in a perspective view, with the road surface and the geological layers clearly visible.

Station	Elevation	Geological Feature
133	+32.5	Fern Haven Junction
132	+32.7	
131	+32.7	
130	+32.0	
129	+32.2	
128	+32.2	
127	+32.7	
126	+32.7	
125	+23.2	
124	+1.8	
123	+245	



new Fairhaven bridge. Charles S. Ashley, Mayor. William F. Williams, Engineer.

NEW YORK, N. Y.—The Board of Public Improvements has passed resolutions authorizing rebuilding the bridge over Gowanus Canal on Hamilton avenue, Brooklyn, at a cost of \$100,000; also another at Ninth street, Brooklyn, at \$70,000.

OAKLAND, CAL.—R. W. Snow, Mayor of Oakland, informs us that the City Council is having an estimate made of the cost of a bridge over Commerce street, but these figures are only to be used as a basis for an issue of bonds for the improvement, which, together with some others, will probably be voted upon within twelve months.

OMAHA, NEB.—City Engineer Andrew Rosewater has submitted plans to the railroad companies for the proposed Twenty-fourth street viaduct over the tracks. Work is expected to be authorized this winter. (Oct. 5, p. 660.)

OWEGO, N. Y.—A special meeting of the New York Railroad Commissioners was held here on the 19th, to take action looking toward a change of grade at a number of crossings on the Erie road, including the one at Hale's Eddy.

PHILADELPHIA, PA.—The Select Council has passed a bill to permit David A. Baker to build a bridge across Bosler street east of Eleventh.

PONCA, NEB.—Bids for all county bridge work for 1901 are wanted, Jan. 9. J. A. Echroth, County Clerk.

PORTLAND, ME.—The War Department has notified Mayor Robinson that the draw of Vaughan's bridge to South Portland must be made wider. Estimates were made about one year ago for a new steel bridge about 1,314 ft. long, at \$230,000.

RICHMOND, VA.—We are informed that bids are wanted at once for a steel truss bridge 1,460 ft. long, to cross James River at Richmond, for the Mayo Land & Bridge Co. Ware B. Gay, President of the Company, will receive the bids.

SULLIVAN, IND.—The County Commissioners want bids, Jan. 11, for bridges of different construction. J. M. Lang, County Auditor.

SYRACUSE, N. Y.—The Board of Contract and Supply has directed the City Engineer to estimate the cost of a bridge to replace the present hoist bridge over the Oswego canal at North Salina street and Belden avenue.

THOMPSON, CONN.—The Selectmen of the town of Thompson have petitioned for the elimination of grade crossings in that town known as Thompson turnpike and Marcy road, which cross the tracks of the New York, New Haven & Hartford and the relocation of a highway not at grade, which now crosses the tracks of the Norwich & Worcester near North Grosvenordale. Hearings will be given by the Railroad Commissioners, Dec. 27, at Thompson.

WACO, TEXAS.—Plans are reported accepted for the proposed bridge over the Brazos River, for which \$100,000 bonds will be issued. (Nov. 23, p. 782.)

Other Structures.

BUFFALO, N. Y.—The New York Central paint and car shops in Lovejoy street, were destroyed by fire on Dec. 19, causing a loss of about \$30,000, \$20,000 of which is on cars.

CHARLOTTEVILLE, VA.—The Chesapeake & Ohio will build a stone and brick station here at a cost of about \$25,000.

CHICAGO, ILL.—Messrs. Nye, Jenks & Co., operating the 1,250,000-bushel elevator at Duluth, Minn., and smaller houses at Washburn and Milwaukee, have made plans to build a 1,000,000-bushel house at Chicago. The Chicago Company is called the Rialto Elevator Co., and the structure will be of steel and cement and fireproof. It will cost over \$400,000.

LOUISVILLE, KY.—The Louisville Bolt & Iron Company will add a rolling mill to the plant to cost in the neighborhood of \$30,000, to make bars for use in making bolts. The plant will be located at South Louisville. L. S. Taylor is President.

ST. JOHN, N. B.—The Coldbrook Rolling Mills, situated fifteen miles from this city, were burned, Dec. 19. They were owned by the Coldbrook Steel & Iron Company. Loss, \$100,000.

TOLEDO, OHIO.—The Wabash will build a passenger station in this city in the near future, according to report.

WEEHAWKEN, N. J.—The Board of Directors of the New York Central has authorized the building of a new grain elevator at Weehawken, to cost about \$1,750,000.

MEETINGS AND ANNOUNCEMENTS.

(For dates of conventions and regular meetings of railroad associations and engineering societies see advertising page xi.)

Railway Transportation Association.

The winter meeting of the Railway Transportation Association will be held at the Grand Hotel, Cincinnati, Ohio, 10 a. m., Wednesday, Jan. 16. Reports of committees on the following subjects will be considered: General Transportation Topics; Car Service; Interchange and Distribution; Tonnage Rating of Engines; Loading Freight Cars to Their Full Capacity; Scope and Character of Organization.

A cordial invitation is extended to railroad officers interested in transportation subjects to be present at this meeting. G. P. Conard, Secretary, 24 Park Place, New York.

Car Foreman's Association.

The regular meeting of the Car Foremen's Association of Chicago was held in Room 209 Masonic Temple, Wednesday evening, Dec. 12. There were about 80 present, and 60 new members were added. The membership now numbers nearly 350. The Committee on "Labor Allowance for Renewing Draft Timbers on Refrigerator Cars" presented an interesting report embodying the ideas of the men who do the actual work. This report will be discussed at the next meeting. In the discussion on hot boxes, Mr. W. J. Walsh, of the Gakona Oil Company, described the causes of hot boxes, the preparation of packing and the care of boxes to prevent their running hot. In regard to the price charged for Pintsch gas furnished, the general opinion was that 85 cents was the only charge that should be made. Mr. H. H. Harvey, of the Chicago, Burlington & Quincy,

presented a paper on the "Best Methods of Repairing Air-Brakes," exhibiting in each case the tools recommended for this work. This paper will also be discussed at the next meeting.

The New York Railroad Club.

The meeting of the New York Railroad Club, Thursday evening, Dec. 20, was largely attended. The paper presented was on "Railroad Tunnels; Their Construction, Maintenance and Operation," by Mr. J. V. Davies, C. E. It treated of the construction of tunnels under almost every conceivable condition, and was well illustrated by a series of lantern slides, among the views being some taken from the Boston Subway, the Reading Subway at Philadelphia, and the underground work of the Budapest Electric Railroad. Illustrations of preparatory and completed work were given, as relating to the work above mentioned, and also of railroad work in various places as now being done by the firm of which Mr. Davies is a member. Tunneling, with the accompanying of compressed air tools and air locks, and also self-supporting earth and rock-work excavations, were exhaustively treated. The paper was voted a valuable one, and the proceedings for this meeting will make interesting reading. The paper brought out a rather short discussion. One interesting statement made by Mr. Davies was that records taken in England show that the reduction of the section of rail per yard, per annum, is nine times as great inside of tunnels as it is in the open air. This Mr. Davies attributed to the lack of ventilation, and its entailed results. He also described various methods of ventilating that are now used. Twenty-seven members were elected and the names of 16 applicants for membership were presented. "The New Method of Rating and Loading Freight Engines," a paper to be presented by Thomas Tait (C. P. Ry.), was announced as the subject for the next meeting.

Western Railway Club.

A meeting of the Western Railway Club was held at the Auditorium Hotel, Chicago, Tuesday afternoon, Dec. 18. The first paper was by Mr. Ira C. Hubbell, entitled "Suggestions as to Fuel Economy." The point that Mr. Hubbell brought out was that by means of an attachment to the ordinary link motion of the steam distribution can be materially improved, and also through this attachment it becomes possible to reduce the cylinder clearances. With 20 x 26-in. cylinders, it is held to be possible to make the clearance about 2 per cent. with $\frac{1}{4}$ -in. striking distance, instead of 8 to 10 per cent., which is common. With $\frac{3}{8}$ -in. striking distances, it is claimed the clearance can be made about $\frac{2}{3}$ per cent. Mr. Hubbell expects a fuel saving of from 20 to 25 per cent. to result from these changes in clearance. Mr. F. H. Clark, Mechanical Engineer of the Chicago, Burlington & Quincy, said in his opinion it was hardly possible to design the steam passages and provide a suitable striking distance and make the clearance volume much less than 4 per cent. of the piston displacement. Prof. W. F. M. Goss agreed that if Mr. Hubbell's ideas as to improving the form of the indicator diagram and reducing clearance can be carried out in practice, it will give a very good engine.

A paper by Mr. W. H. Graves, Foreman on the Burlington & Missouri River, on locomotive fire-box patches brought out considerable discussion. The paper advocated raised patches in preference to flat patches. Many of the speakers had used both kinds and in general agreed with the writer of the paper, that the raised patches, if properly applied, give little trouble from leaking. The Chicago & Northwestern has been following this practice on some divisions for 18 years.

The discussion of Mr. S. P. Bush's paper on "Car Journals and Hot Boxes," published last week, brought out no points which did not appear in the paper.

PERSONAL.

(For other personal mention see Elections and Appointments.)

—Mr. Frank F. Robb, whose transfer to Allegheny City as a Division Superintendent of the Pennsylvania, was noted last week, was born in Philadelphia, Nov. 7, 1858. He began his railroad service as a rodman in the office of the Principal Assistant Engineer of the Pennsylvania at Altoona on Nov. 1, 1879, and has since continued with that company. He served successively as Assistant Supervisor, Supervisor and Assistant Engineer of a number of divisions until Jan. 1, 1893, when he was appointed Superintendent of the Bedford Division. He was transferred to the Cambria & Clearfield Division on Oct. 8, 1894, and to the Monongahela Division on Feb. 1, 1899.

—Mr. J. S. Turner, whose appointment as Superintendent of Motive Power and Equipment of the Toledo, St. Louis & Western is noted in another column, was for some time Superintendent of Motive Power of the Fitchburg R. R., and continued to perform similar duties as Master Mechanic of the Fitchburg Division of the Boston & Maine, after the consolidation of those two roads. Mr. Turner, although a comparatively young man, has been identified with the motive power department of several large roads. His first experience was with the Pennsylvania R. R., and he later served with the Mexican Central, Mexican International, West Virginia Central and Colorado Southern roads.

—Mr. Charles A. Goodnow, who succeeds Mr. Underwood as General Superintendent of the Chicago, Milwaukee & St. Paul, began his railroad career as telegraph operator on the Vermont & Massachusetts (Fitchburg). He was chief train dispatcher of the Troy & Greenfield for several years while it was operated by the state, and from there, in 1881, went to the New Haven & Northampton, as Superintendent. Five years later Mr. Goodnow went West and for a short time was Superintendent of Construction on the Chicago, Milwaukee & St. Paul, but was soon made Division Superintendent at Marion, Iowa. In 1895 he was promoted to the office of Assistant General Superintendent, at Chicago.



—Mr. H. M. Fickinger is the new Superintendent of the Kansas City, Fort Scott & Memphis and the Kansas City, Memphis & Birmingham. He was born in Kingsville, Ohio, Nov. 14, 1848, and entered railroad service as a telegraph operator on the Cleveland & Erie (now Lake Shore & Michigan Southern) in 1868. About two years later he was appointed chief operator of the Franklin Division of the Lake Shore, and several months later chief dispatcher of the Franklin and Youngstown Divisions, which positions he held until 1881. Mr. Fickinger then became Superintendent of the Sinaloa & Durango in Old Mexico, where he spent two years. He was Superintendent of the Kansas, Nebraska & Dakota during building and operation and until several months after its absorption by the Missouri Pacific. For three years he was Superintendent, General Freight and Passenger Agent of the Kansas City, Fort Smith & Southern, and for seven years Traveling Passenger Agent of the Memphis Route. Then for a year he was Northwestern Passenger Agent of the St. Louis & San Francisco at Kansas City. For 16 months prior to his recent appointment he was Commercial Agent at Colorado Springs for the Colorado & Southern.

ELECTIONS AND APPOINTMENTS.

Atchison, Topeka & Santa Fe.—After Jan. 1, 1901, the limits of the Western Division are extended from Dodge City to Raton, not including Raton Station; and from La Junta to Canon City, not including Pueblo Station. F. C. Fox has been appointed Superintendent, with headquarters at La Junta, Colo. The Colorado Division has been created, extending from Pueblo to Denver. R. J. Parker, Superintendent, with headquarters at Pueblo, Colo. T. S. Stevens has been appointed Signal Engineer at Topeka, Kan., succeeding J. S. Hobson, resigned, effective Dec. 17.

Boston & Maine.—L. C. Todd has been appointed Master Mechanic of the Fitchburg Division, with headquarters at Charlestown, Mass., succeeding Mr. Turner resigned. (See Toledo, St. Louis & Western.) C. B. Hutchinson becomes Master Mechanic of the Connecticut & Passumpsic Division, north of White River Junction, at Lyndonville, Vt., succeeding Mr. Todd.

Buffalo & Susquehanna.—H. C. Underhill, General Freight and Passenger Agent at Buffalo, N. Y., has resigned to engage in business for himself, effective March 1.

Chicago & Alton.—Wm. M. Corbett, heretofore Superintendent of the Evansville & Terre Haute, has been appointed Superintendent of the Middle Division of the C. & A., in charge of the lines from Bloomington to St. Louis and from Springfield to Peoria, with headquarters at Springfield, effective Jan. 1.

Chicago & Northwestern.—H. Crane, Superintendent of Bridges and Buildings, at Janesville, Wis., has resigned.

Chesapeake & Ohio.—On Jan. 1, 1901, the following appointments are effective: C. E. Doyle, General Manager, with headquarters at Richmond, Va.; J. M. Gill, General Superintendent of the Western Division, at Huntington, W. Va.; C. C. Walker, General Superintendent of the Eastern Division at Richmond, Va., succeeding Mr. Doyle; J. W. Knapp, Superintendent of the Richmond Division, at Richmond, Va.; J. H. Carlisle, Superintendent of the Huntington Division, at Hinton, W. Va.; E. W. Grice, Superintendent of the Clifton Forge Division, at Clifton Forge, Va.; G. W. Lewis, Superintendent of the Kentucky Division, at Ashland, Ky.; H. C. Boughton, Superintendent and General Agent of the Greenbrier Division, at Ronceverte, W. Va., and J. W. Haynes, Superintendent of Terminals of the Cincinnati and Covington Division, at Cincinnati, Ohio.

Danville & Western.—J. A. White has been appointed Superintendent, with headquarters at Danville, Va.

Great Northern.—We have excellent authority for denying the various newspaper reports, that several changes were to be made among the officers of this company. It follows from this, that J. F. Stevens, Chief Engineer, will not become General Manager. J. C. Nolan, heretofore Assistant Division Superintendent, has been transferred as Master Mechanic at Havre, Mont.

Illinois Central.—J. F. Wallace has been appointed Assistant General Manager. A. W. Sullivan becomes Assistant Second Vice-President, succeeding Mr. Wallace. The position of General Superintendent, heretofore held by Mr. Sullivan, is abolished. J. W. Higgins, heretofore Superintendent of Transportation, has been appointed General Superintendent of Transportation. Mr. Higgins' former position is abolished. H. W. Parkhurst has been appointed Engineer of Construction. All with headquarters at Chicago, Ill. J. G. Hartigan, Assistant General Superintendent of the Northern and Western Lines, has resigned and the position is abolished. The General Superintendent of Transportation in charge of passenger and freight traffic; Superintendent of Machinery, Superintendent of Telegraph, Chief Engineer, Consulting Engineer, Engineer of Construction in charge of all construction work not otherwise assigned to the Chief Engineer, Chief Surgeon, Chief Claim Agent, Chief Special Agent, Assistant General Superintendent, whose jurisdiction extends over the railroads south of the Ohio River, discharging all the duties and exercising all the powers of the Assistant General Manager (except as to matters pertaining to maintenance of way, when he shall report to the Chief Engineer) and Superintendents on the Northern and Western Lines, will report to the Assistant General Manager. Mr. Wallace, the Assistant General Manager, will report to the Second Vice-President. Effective Jan. 1.

Kansas City, Memphis & Birmingham.—W. H. Churchill, heretofore Trainmaster, has been appointed Division Superintendent at Amory, Miss.

Little Miami Traction.—The officers of this company, referred to in the Construction column, are: President and General Manager, John P. Martin, Xenia, Ohio; Vice-President, Chas. J. Christie, Cincinnati, Ohio; Treasurer, Rufus R. Ranney, Detroit, Mich.; Secretary, Charles Orr, Cleveland, Ohio; Chief Engineer, W. D. Riddell, Xenia, Ohio.

McCloud River.—On Dec. 19, Geo. W. Scott was elected President, succeeding W. E. Brown, deceased.

New York, Philadelphia & Norfolk.—R. B. Cooke, heretofore General Freight and Passenger Agent, has been appointed Traffic Manager.

Pittsburgh & Western (B. & O.).—Robert Finney, heretofore Acting General Superintendent, has been appointed General Superintendent, with headquarters at Allegheny, Pa.

Toledo, St. Louis & Western.—J. S. Turner has been ap-

